



W7 : Management de la valeur E&P et front-end development



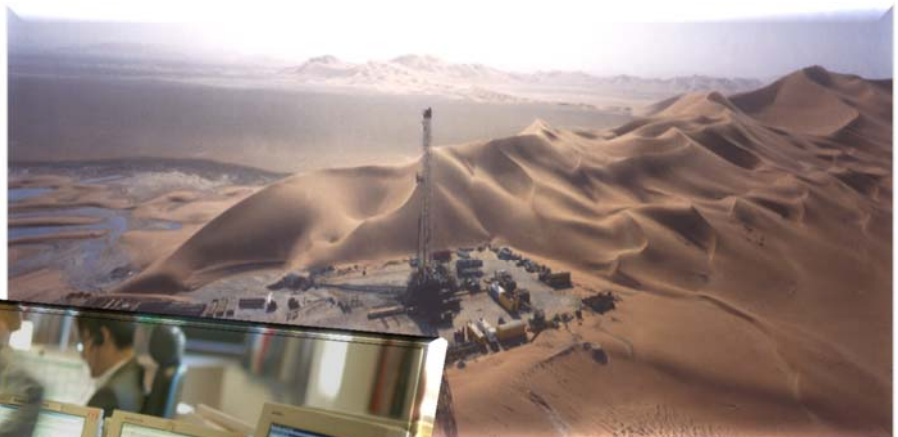
Formation certifiante en Management de la chaîne de valeur de l'EP et
Ingénierie pétrolière – Du 29 Janvier au 02 Février 2017



E&P VALUE MANAGEMENT AND FRONT-END DEVELOPMENT

*IFP*Training

*IFP*Training



**E&P VALUE MANAGEMENT
AND
FRONT-END DEVELOPMENT**

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Strategic Issues in Exploration-Production

Requirements for decision in the oil and gas industry

Oil and Gas Industry Dynamics

High risk

Capital-intensive investments

Complexity of operations

Profit potential

Oil and gas reserves estimates & Complete economic evaluations

**Petroleum
Engineering Techniques**



**Economic
Modeling and Analysis**

Vital Requirements for important Decision Problems

Sales, Mergers, Acquisitions, Litigations

Financing of Exploration, Field Development and Major Facilities' Projects

Objectives of an economic analysis

- ▶ To place a *monetary value* on a project.
- ▶ To analyze the project *value drivers*.
- ▶ To analyze investment *alternatives*.
- ▶ To prepare *negotiation* positions.
- ▶ To forecast *cash flows* and prepare *budgets*.
- ▶ To track on-going project *performance* versus budget or forecast.

Primary objectives of an oil company

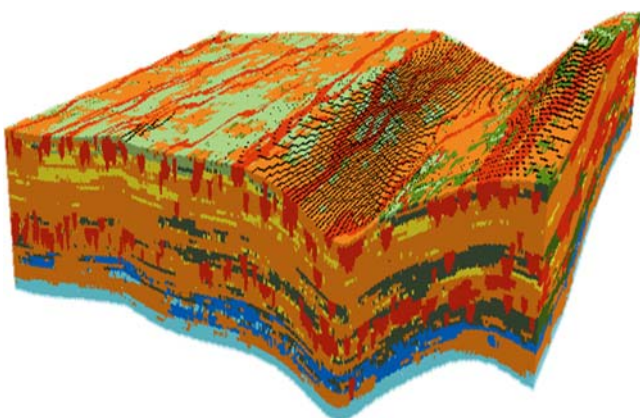
- Add to the *reserves inventory* through exploration or purchase of reserves in the most cost efficient manner,
- Maximize oil and gas *recovery* through research efforts, studies, and use of sound reservoir development and production practices,
- Sustain the highest degree of *reliability* and *availability* of production facilities,
- Conduct all *operations* in the most efficient, cost effective, safe, and environmentally acceptable manner, and
- *Maximize return on investment and total worth of the company.*



Exploration risk and economic risk

Exploration Risk

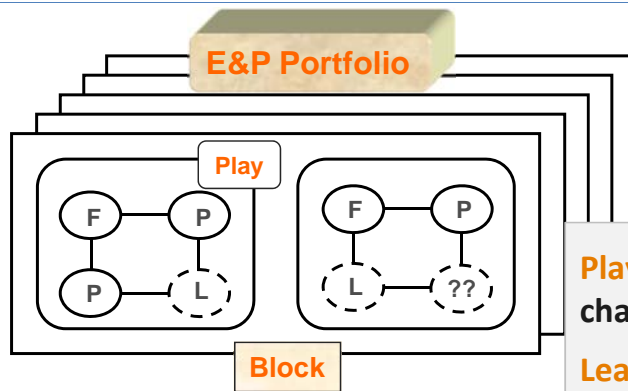
- Probability of success
- Volume of prospect
- Crude oil and/or natural gas
- Quality of hydrocarbons
- Recovery rate



Economic Risk

- Crude oil price
- Capital costs
- Operating costs





Play: geological concept involving common characteristics

Lead: identified target within a play needing more work to justify a drilling proposal

Prospect: identified “ready-to-drill” target

Field: Reservoir under evaluation, or development or in production

NO ONE FINDS OIL WITH
ECONOMICS AND RISK ANALYSIS
BUT THEY CONTRIBUTE TO

CONSTRAIN, RANK, AND SUPPORT

PROJECTS EVALUATION AND CHOICES

THROUGHOUT

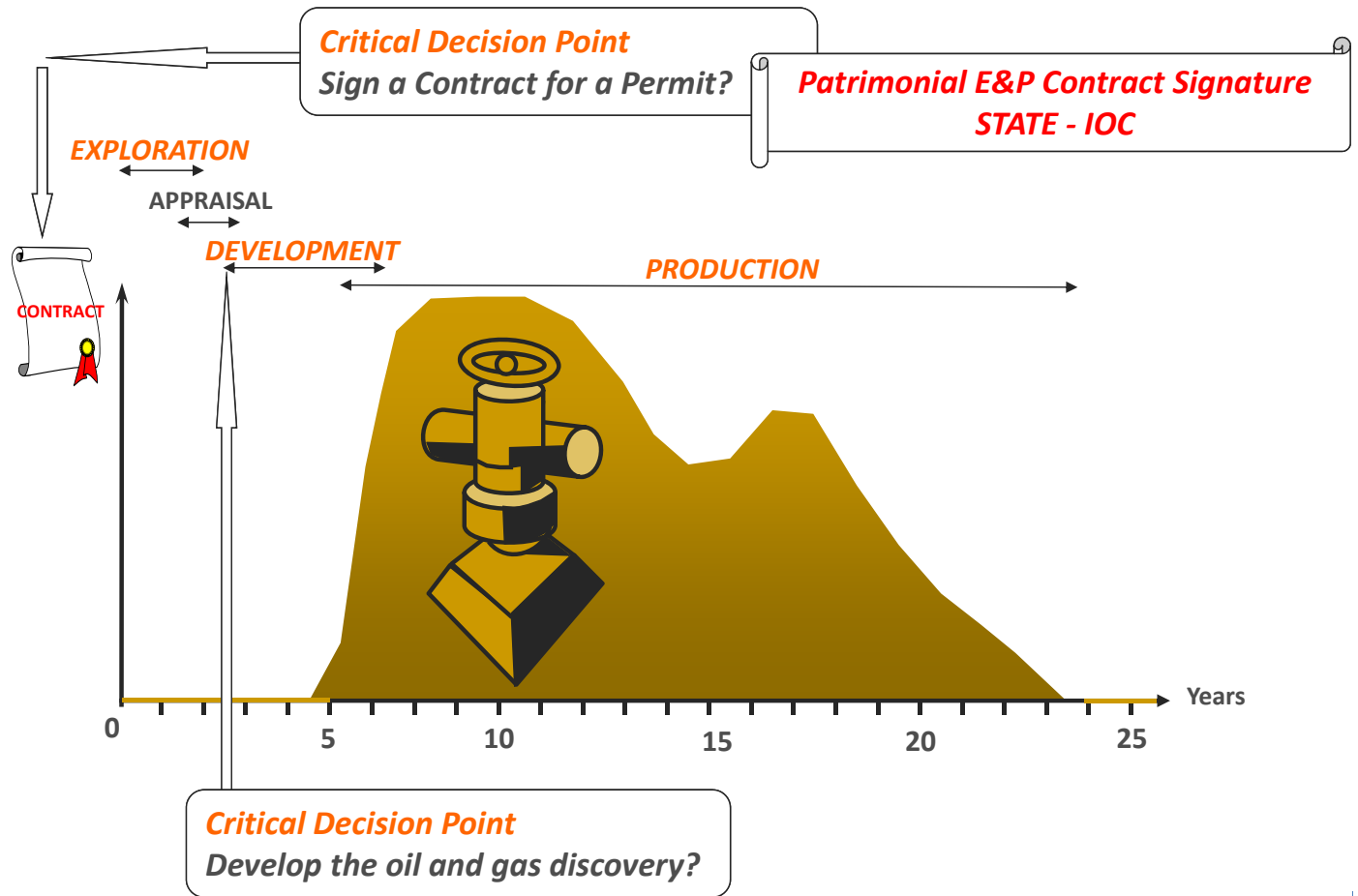
THE EXPLORATION AND PRODUCTION VALUE CHAIN

Keys to E&P value creation

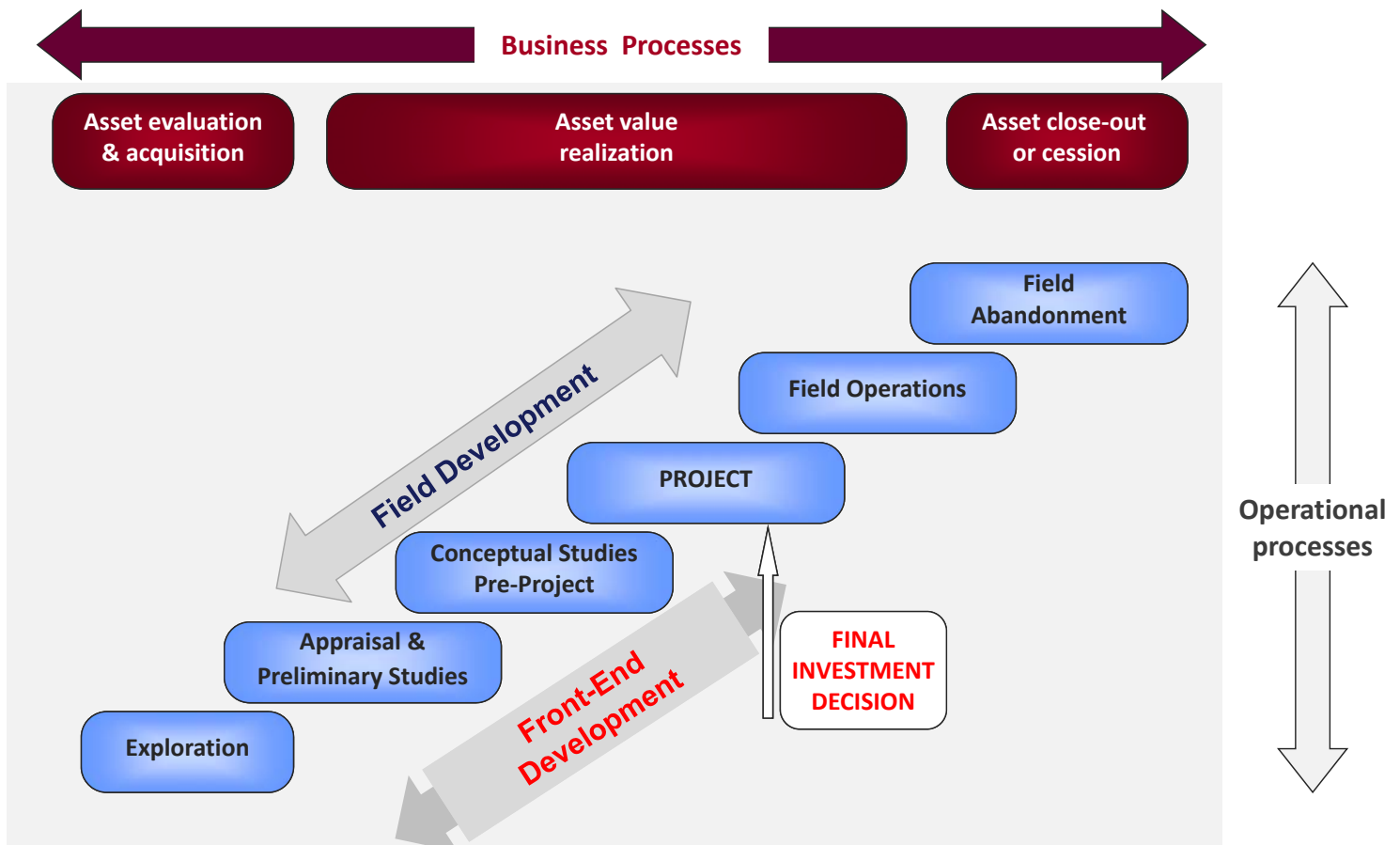
Keys for Success

- Global strategic *vision*.
- Optimism and *risk-taking* attitude.
- High *expertise* in geosciences.
- Mastering of *innovation*.
- Rigorous risk analysis and *management*
from Block to Prospect to Field to Portfolio.
- Balanced equation of *risk / size / value*.
- Organization: synergy of expertise, focused team work,
approval process.

E&P assets: contracts, critical decisions and life cycle



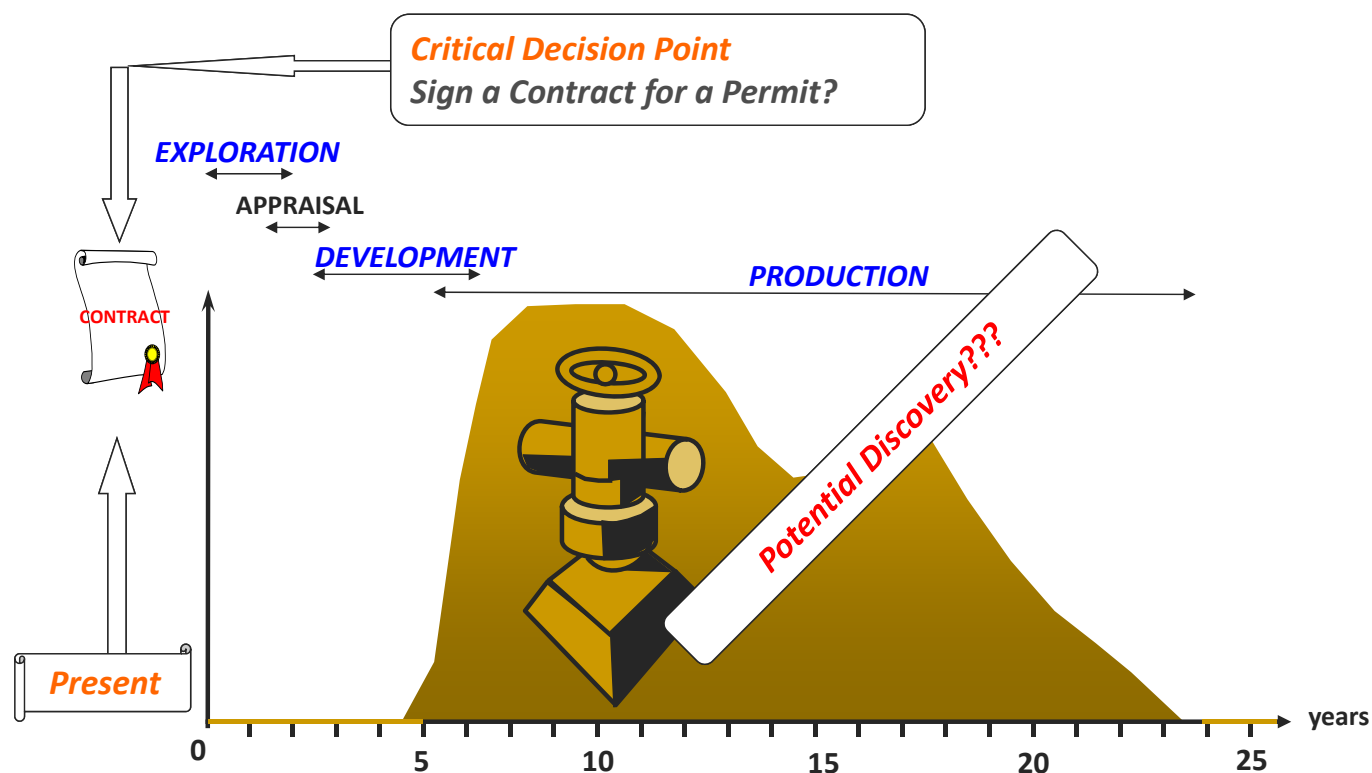
E&P assets: business and operational processes



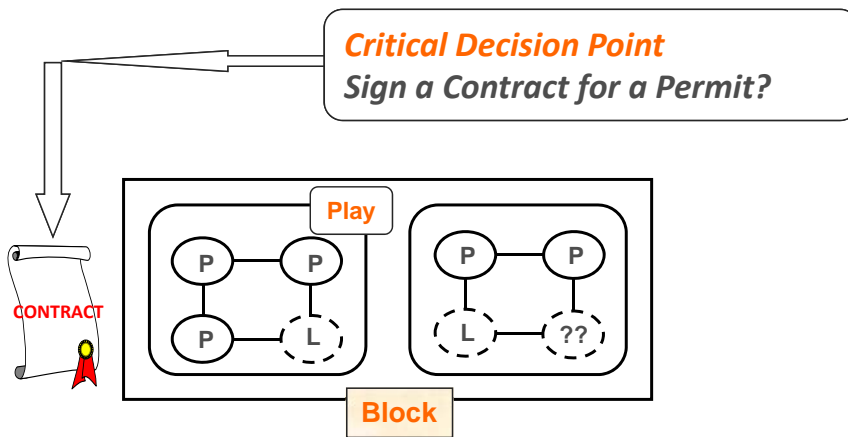
Decision Process from Prospect Evaluation to Exploration Drilling

Explore or not explore a block

"Let's speculate"



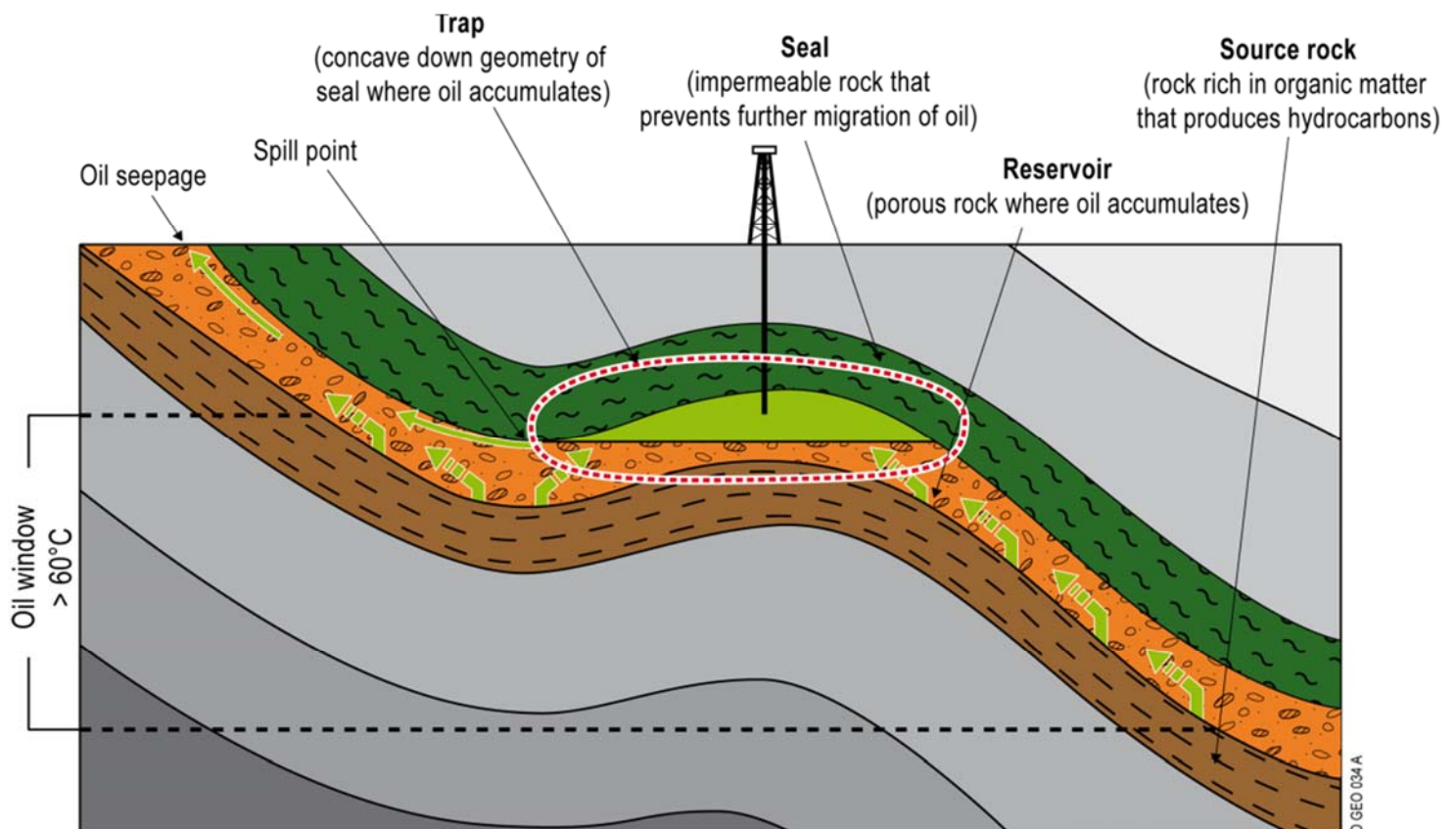
Fundamental questions for a manager



► How much can we expect to gain from this new venture?

- What are my **chances** of finding hydrocarbons?
- What would be the **reserves** of that discovery?
- How much would I have to **spend to make** that discovery?
- How much would I have to **spend to develop** that discovery?
- How much **value** would that discovery bring?

Four components for a prospect



Exploration expertise and techniques

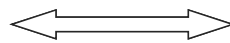


GEOLOGIST

Recreates history of basins to help locate hydrocarbon reservoirs

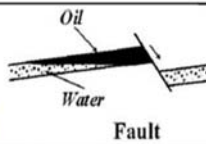
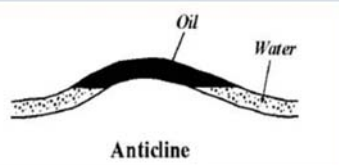
GEOLOGY

- Data: stratigraphic sequence, maps
- Sedimentary basin modeling



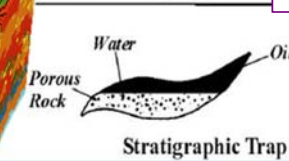
GEOPHYSICIST

Recreates picture of subsurface to help locate hydrocarbon reservoirs



GEOPHYSICS

- Seismic acquisition
- Data processing and interpretation

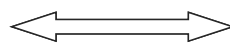


DRILLING ENGINEER

Studies, designs and leads drilling campaigns

DRILLING

- Well logs, cores, fluid samples
- Well testing



Exploration risk analysis

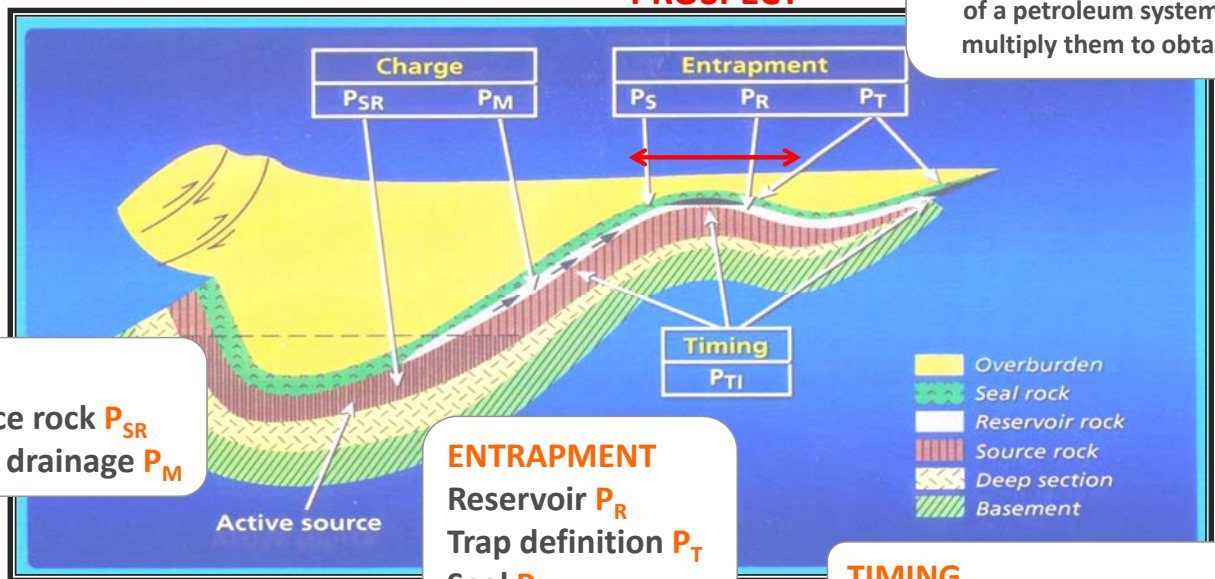
Objective

Evaluate the *Probability of Success (PS)* measuring the chance of finding an accumulation of hydrocarbons.

Methodology

Evaluate the probability of existence of each component of a petroleum system and multiply them to obtain PS

PROSPECT



CHARGE

Active source rock P_{SR}
Migration – drainage P_M

ENTRAPMENT

Reservoir P_R
Trap definition P_T
Seal P_S

TIMING

Migration vs trapping P_{TI}

The failure of any of the 6 parameters means failure of the prospect

Probability of success for an exploration prospect

Example

Risk Analysis

Type hydrocarbons : oil
Efficiency of seal
Presence of seal
Reservoir
Migration
Source rock / Timing

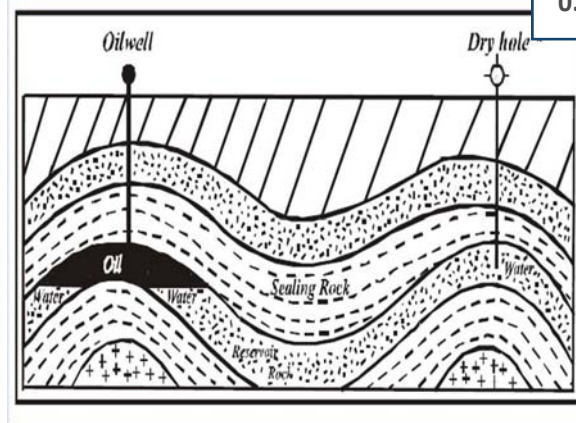
Probability

1.0
0.8
0.7
0.8
0.7
1.0

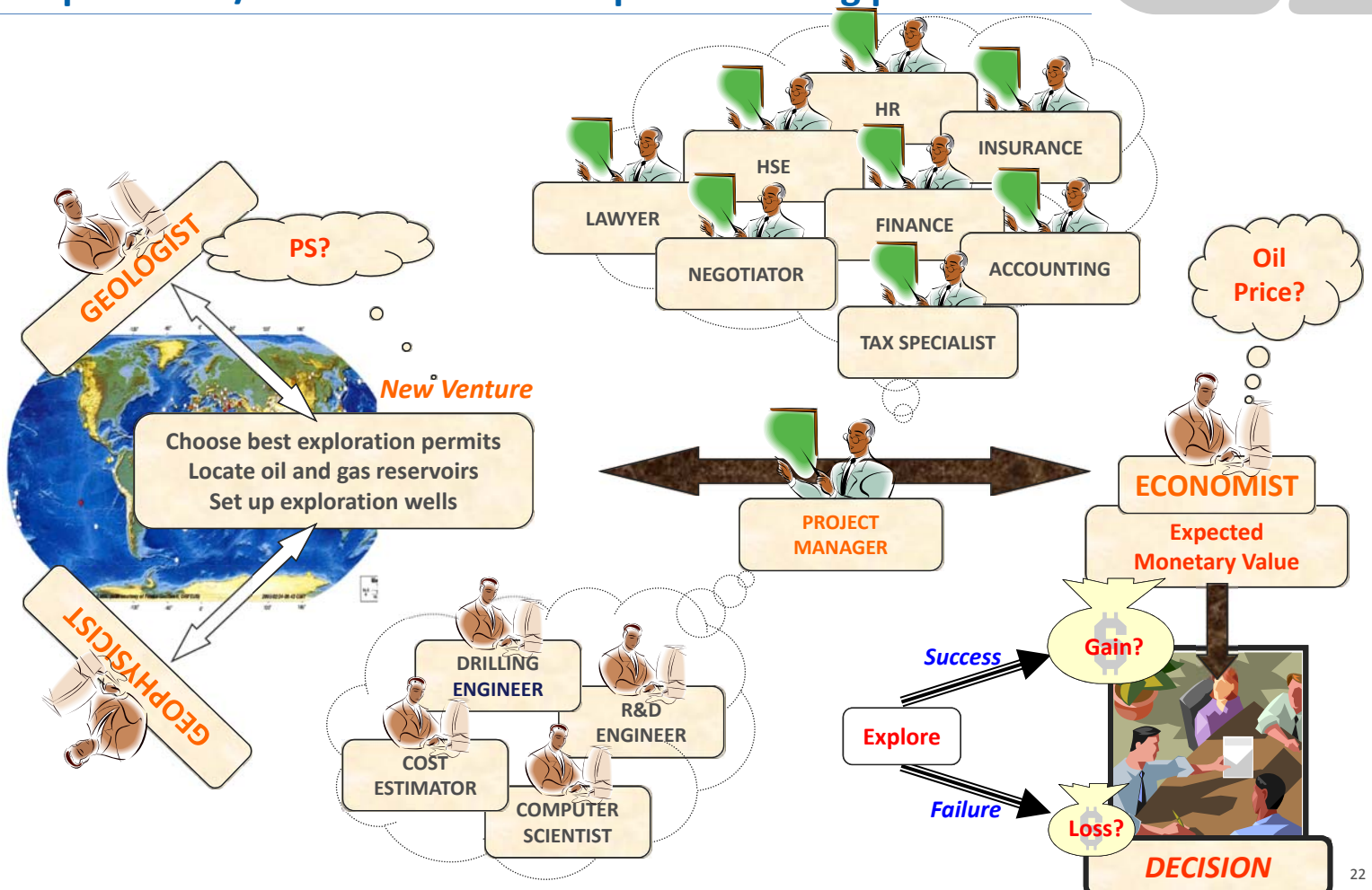
Risk scale

1.0	Negligible risk
0.9	Most likely
0.8	Very likely
0.7	Likely
0.6	More likely than not
0.5	Equally yes or no
0.4	Rather unlikely
0.3	Unlikely
0.2	Very unlikely

Probability of Success **0.31 \approx 1 chance out of 3**



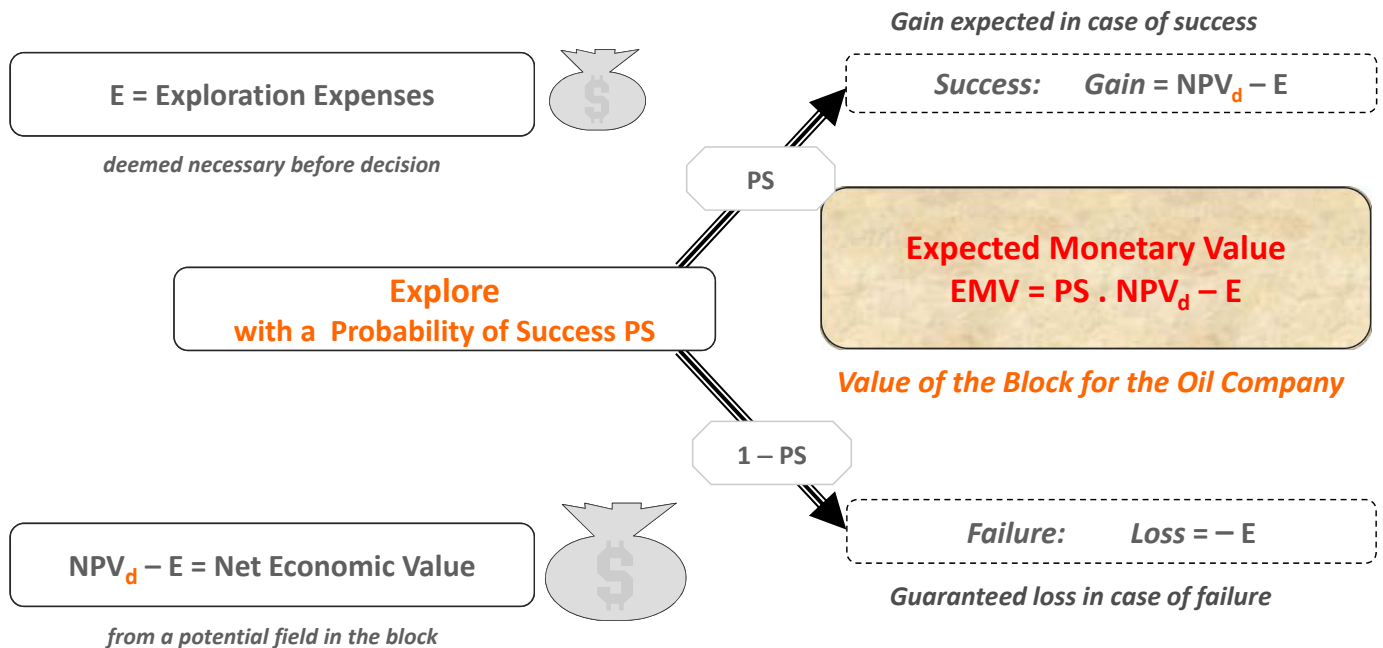
Exploration / Value creation at experts meeting points



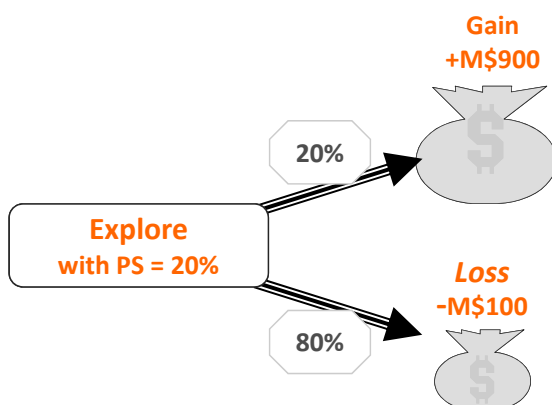
Decision tree analysis for an exploration project

Question : invest or not in the exploration of a block?

Geological Risk is summarized in a "Probability of Success".



Levels of exploration risk



< 15%	High risk ("frontier" exploration / potential basin, unproved plays)
15% < - < 30%	Average risk ("on trend" exploration / proved basin and plays)
30% < - < 50%	Low risk (mature area /proved basin and plays, excellent seismic data)
> 50%	"Very" low risk (appraisal)

Dry Exploration Branch
always very heavy

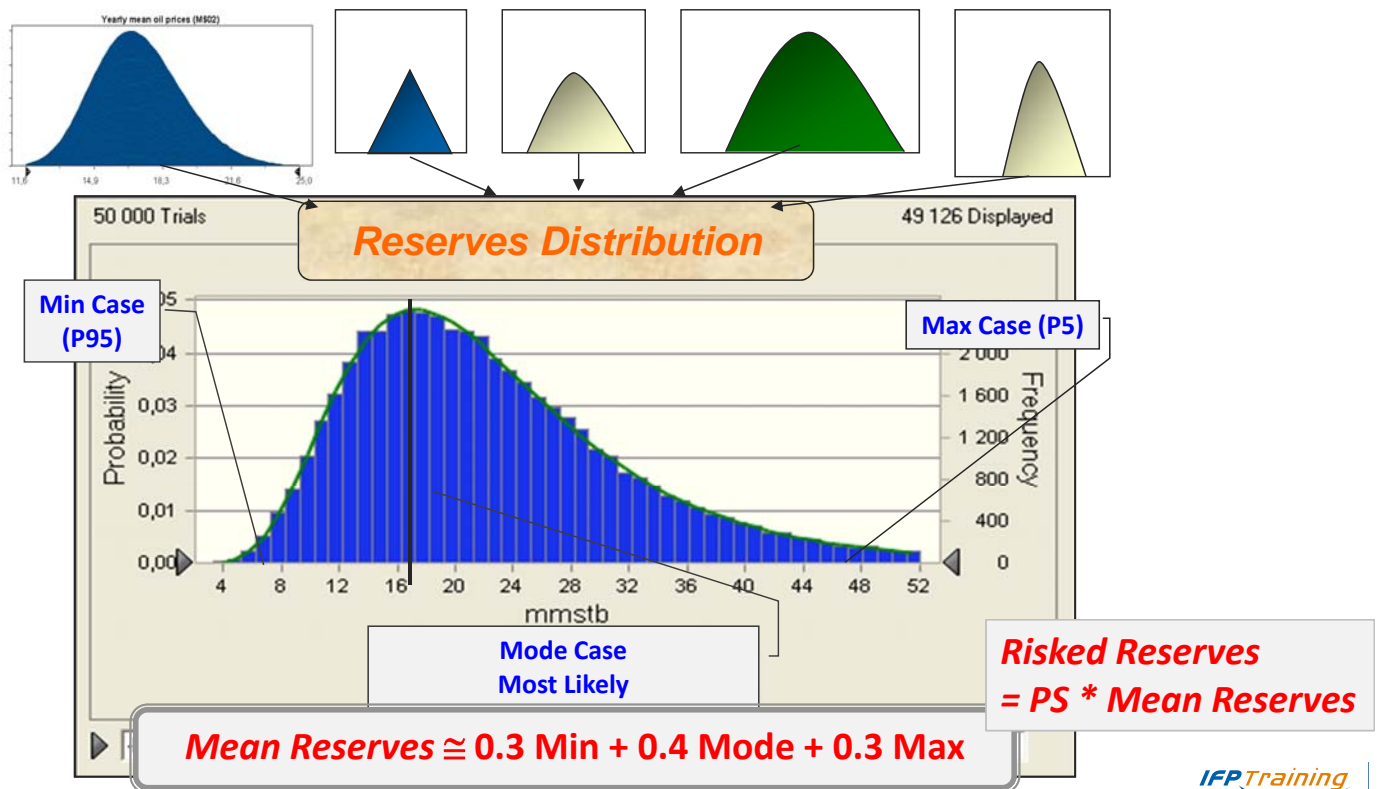
Very Important Factors for EMV
Probability of Success
Oil Price

High value of a potential discovery necessary to compensate for the risk,
provide a reasonable expected monetary value and thus make exploration attractive.

Reserves and uncertainties / Monte Carlo simulation

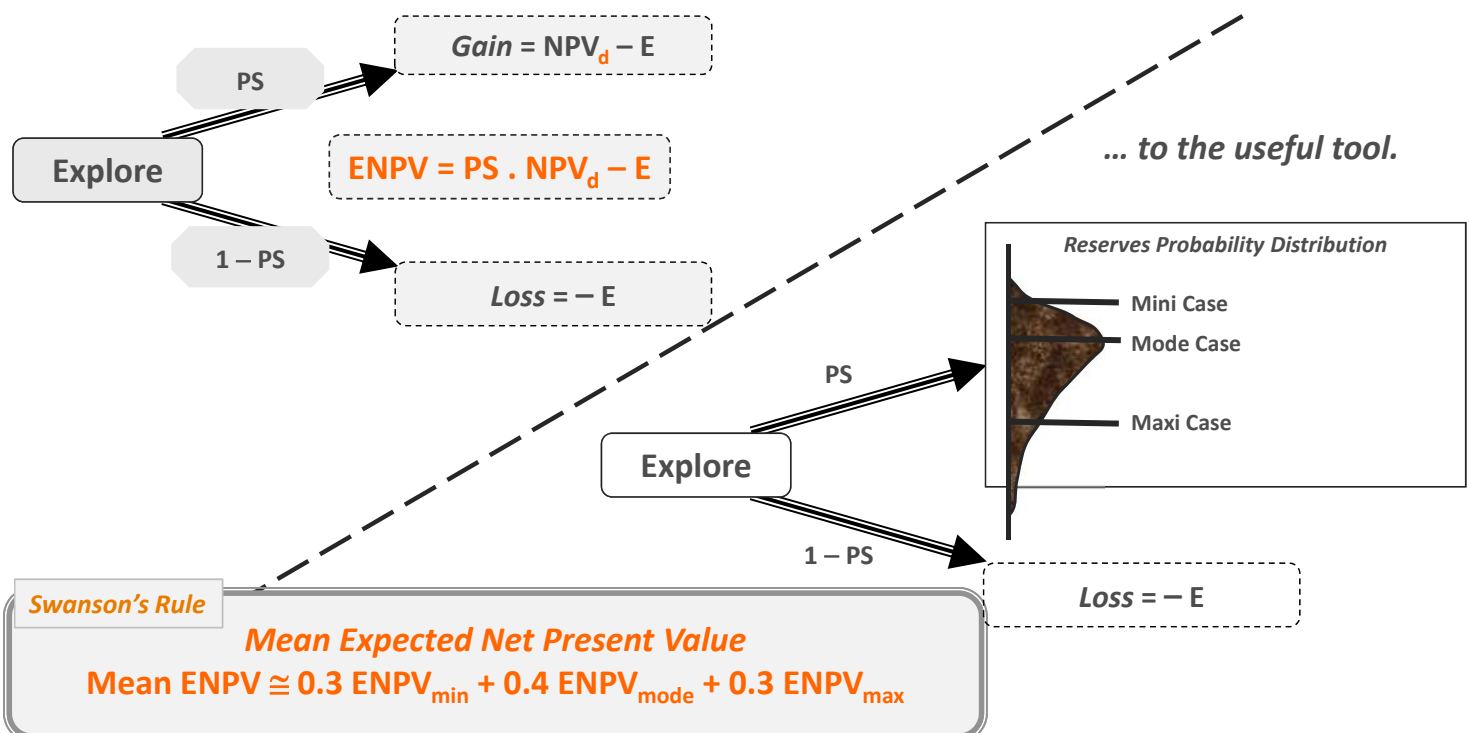
The volume of oil and gas reserves is given by the product of fundamental physical variables
(rock volume, porosity, oil saturation, recovery factor, etc.)

Given the uncertainties, each parameter is described by a probability distribution



3-Scenario approach for value assessment

From the simplest concept ...



This best represents the whole distribution.
Taking into account only the Mode would forget about the strategic impact of a possible big find and generate an overly pessimistic evaluation.

Basis for decision-making in exploration

Exploration Project's Risked Economics

$$\text{Mean ENPV} \cong 0.3 \text{ ENPV}_{\min} + 0.4 \text{ ENPV}_{\text{mode}} + 0.3 \text{ ENPV}_{\max}$$

		Reserves		NPV _d	ENPV = P*NPV _d - E	
		Mbbbl				
Prospect	Success	Maxi	365	580	106	M\$
		Mode	100	142	18	M\$
		Mini	50	62	2	M\$
	P 20%					
1-P 80%						
Dry	-10	-E				

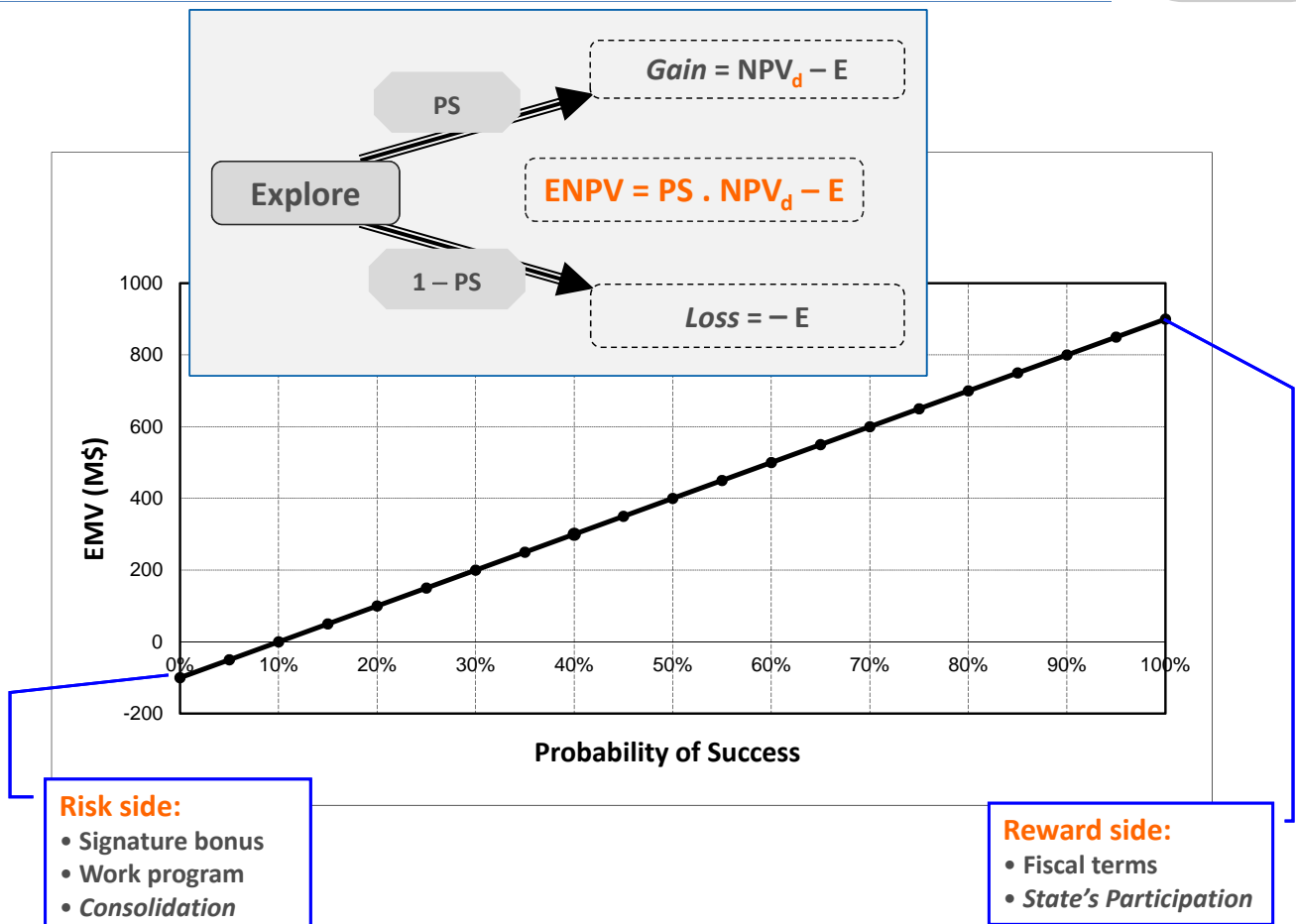
EMV = Mean ENPV = 30% x 2 + 40% x 18 + 30% 106

EMV = 40 M\$

$$\text{EMV} = \text{Mean ENPV} = 30\% \times 2 + 40\% \times 18 + 30\% \times 106$$

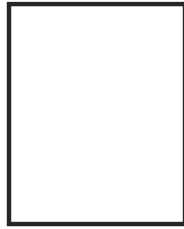
$$\text{EMV} = 40 \text{ M\$}$$

Contractual framework for risk and reward of exploration

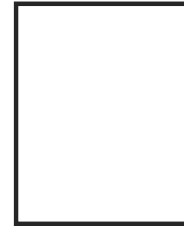


Exploration risk mitigation / Farmout agreement

A (70%) / B(30%)



A (50%) / B(30%) / C(20%)



- ❑ **Farmout** is a transaction by which a company transfers its **participating interest** (or a part of it) in a Contract and the related Joint Operating Agreement, to another company.
- ❑ This transfer of rights to explore for and develop any hydrocarbons discovered is made usually in exchange for a **commitment** to drill a well(s) and/or conduct other exploratory activities.
- ❑ In exchange for this commitment, the party **farming in** is entitled to a **share of the profit** generated by a success.

Exploration risk mitigation / Farmout agreement

HERE IS THE GAME!

Drill alone E = M\$100

Value of potential discovery: $NPV_d = M\$1000$

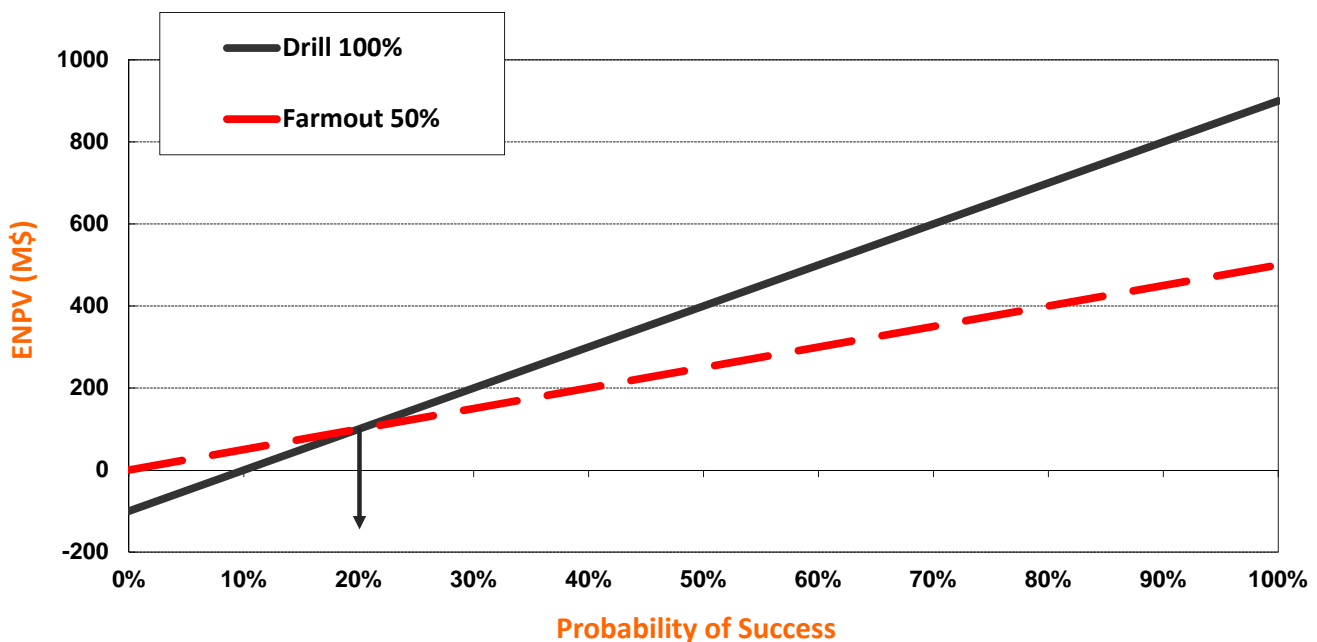
OR

Farm out 50% interest

Cost of drilling taken by the partner

Strategy 1 / $ENPV_1 = PS \cdot NPV_d - E$

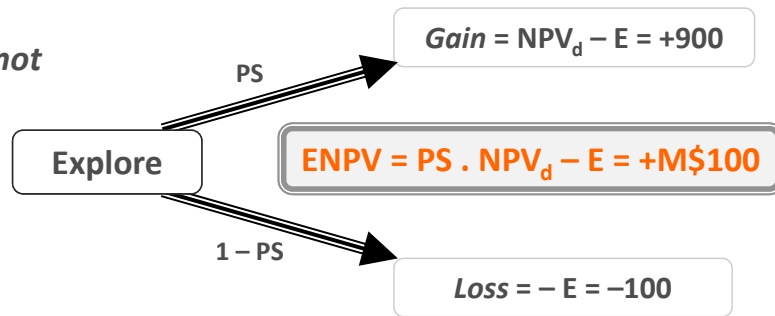
Strategy 2 / $ENPV_2 = PS \cdot 50\% \cdot NPV_d$



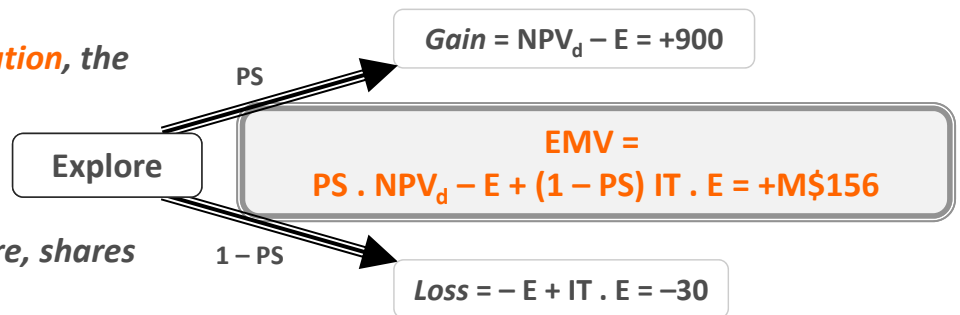
Exploration potential / consolidation of dry exploration

Investment in Exploration $E = \text{M\$}100$
 Value of potential discovery $\text{NPV}_d = \text{M\$}1000$
 Probability of Success $PS = 20\%$

With a **ringfence**, the State does not allow the consolidation of dry exploration, and, therefore, does not share exploration risk with the IOC ...



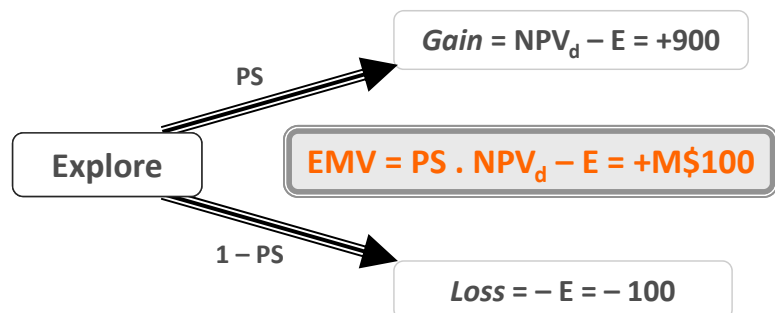
With **consolidation of dry exploration**, the State pays part of that exploration through immediate tax reduction for production coming from other permits, and, therefore, shares exploration risk with the IOC.
 With an Income Tax Rate $IT = 70\%$...



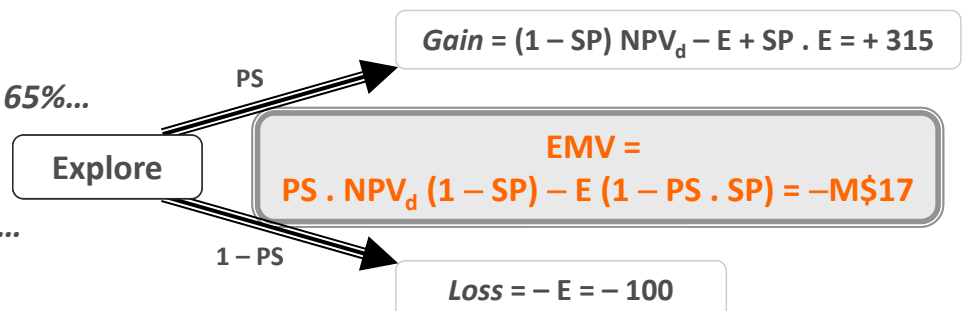
Exploration potential / State's participation

Investment in Exploration $E = \text{M\$}100$
 Value of potential discovery $\text{NPV}_d = \text{M\$}1000$
 Probability of Success $PS = 20\%$

Without State's participation ...



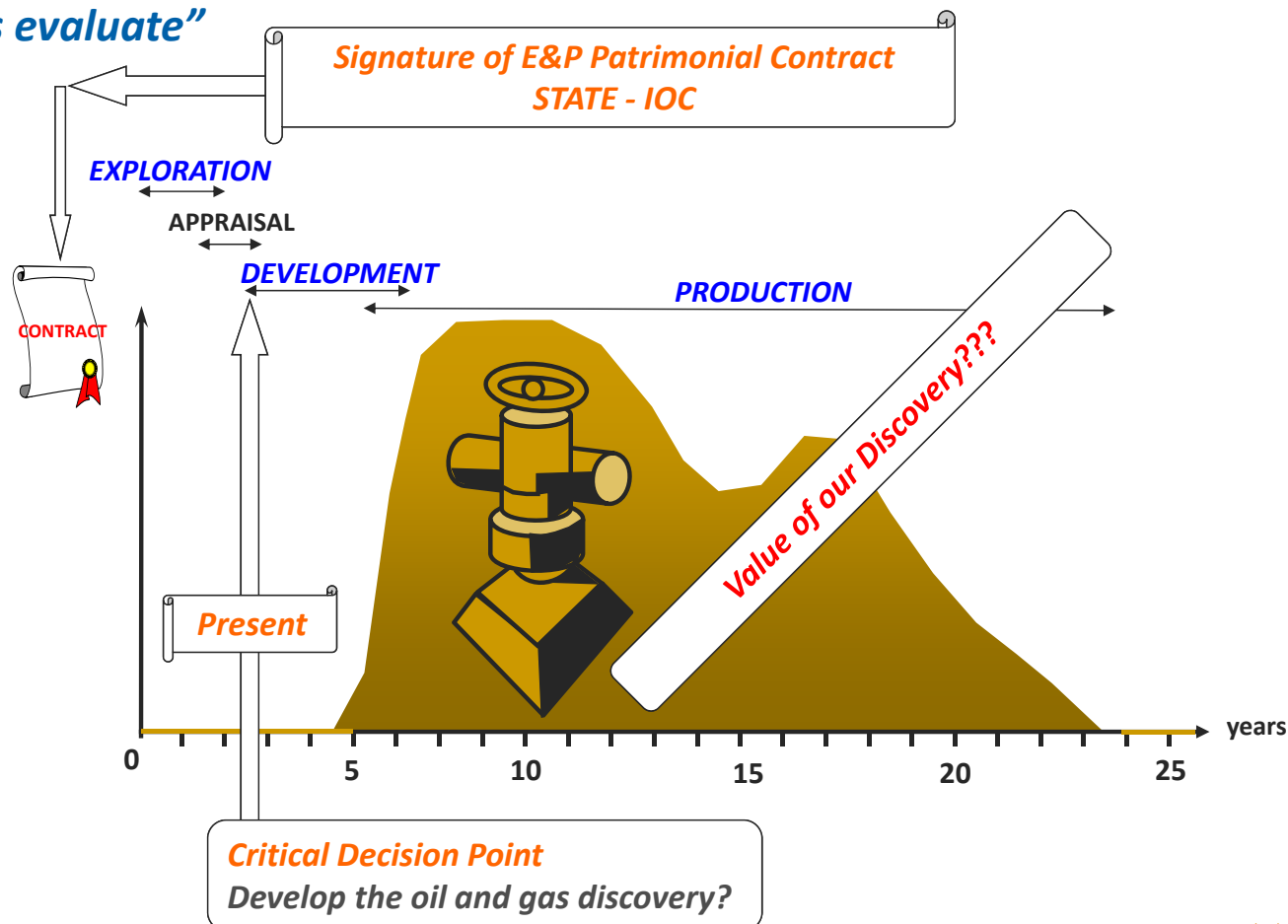
With State's participation $SP = 65\%$...
 Assuming State reimburses exploration only when commercial discovery is made ...



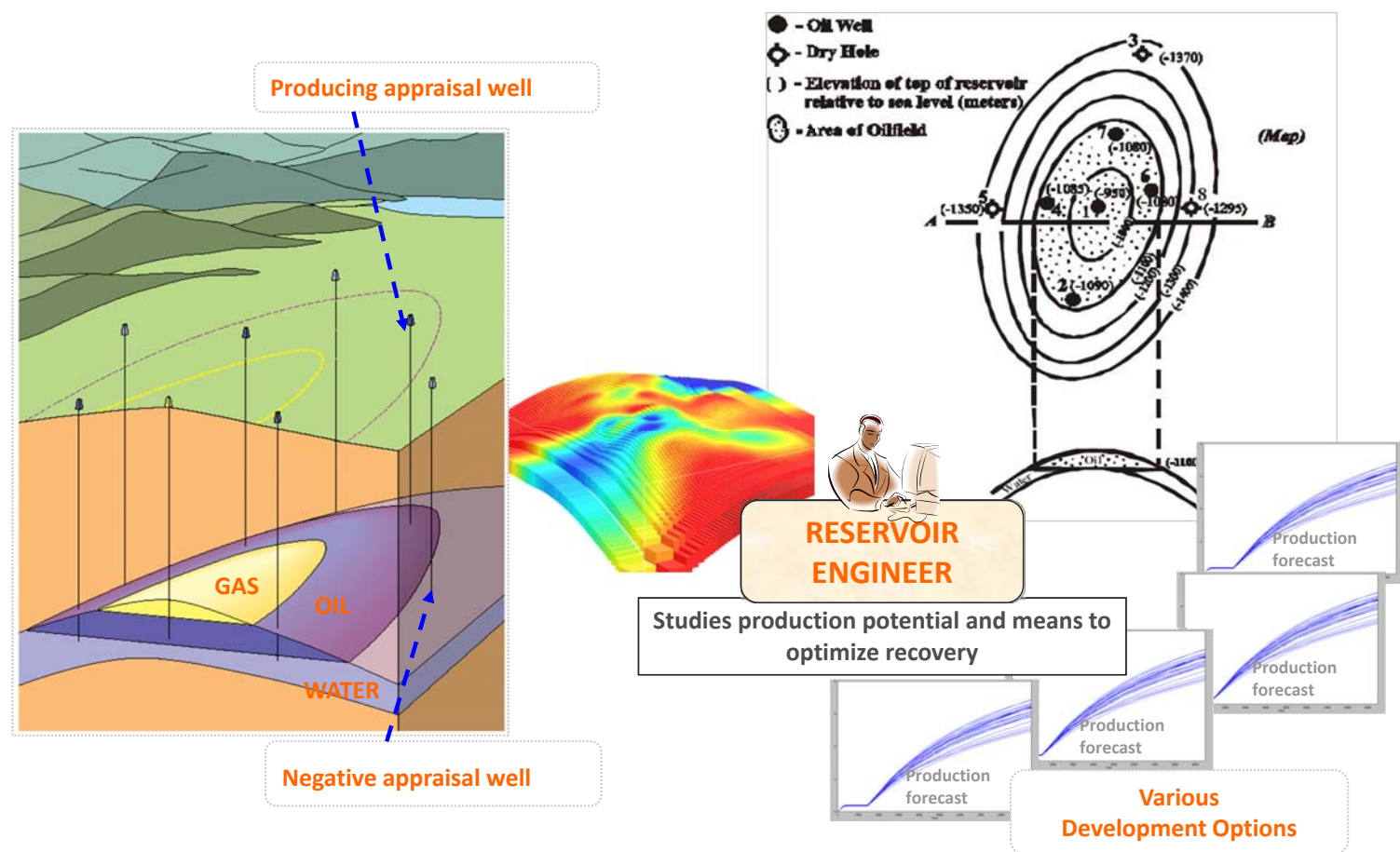
Decision Process from Discovery to Development and Production

Develop or not develop a discovery

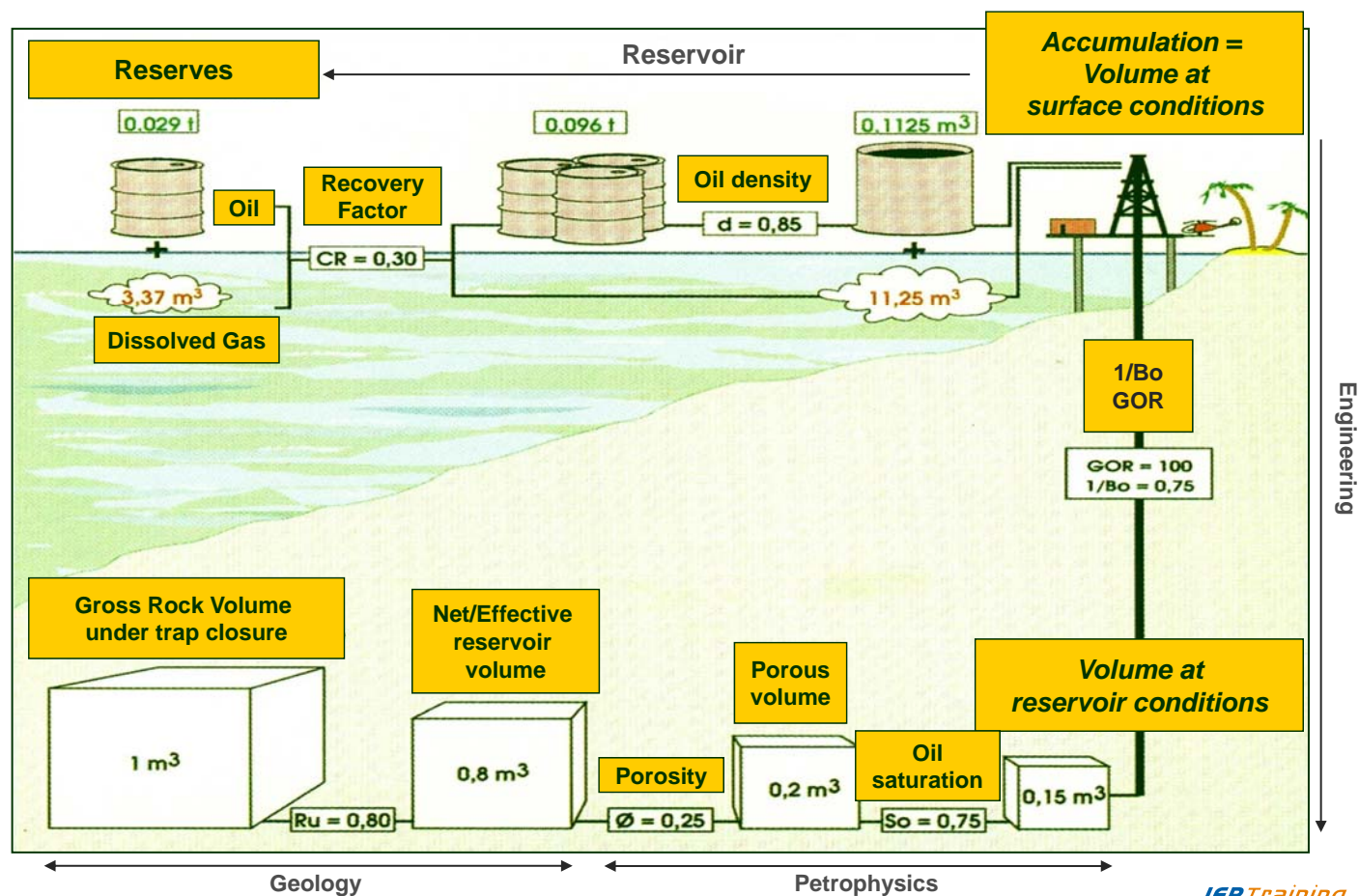
“Let’s evaluate”



Appraisal of a discovery



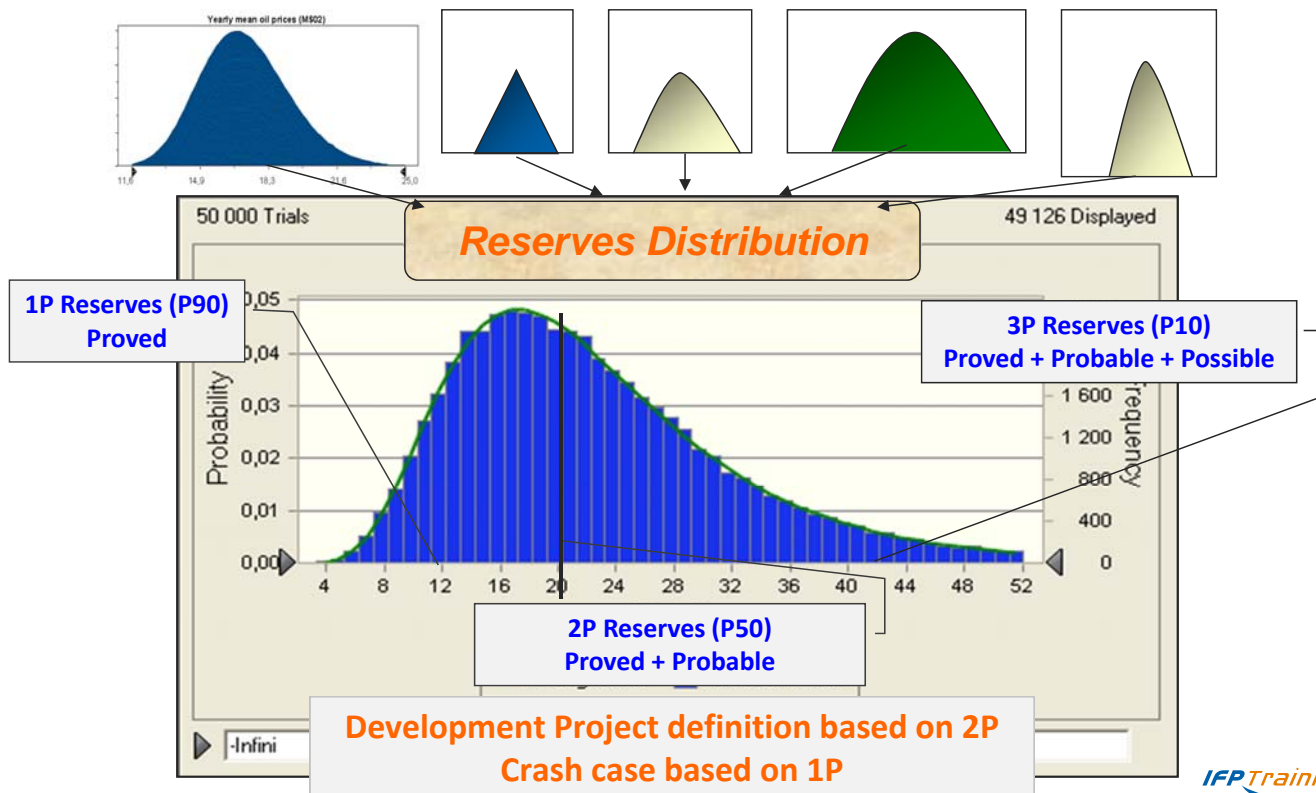
Evaluating reserves



Reserves and uncertainties / Monte Carlo simulation

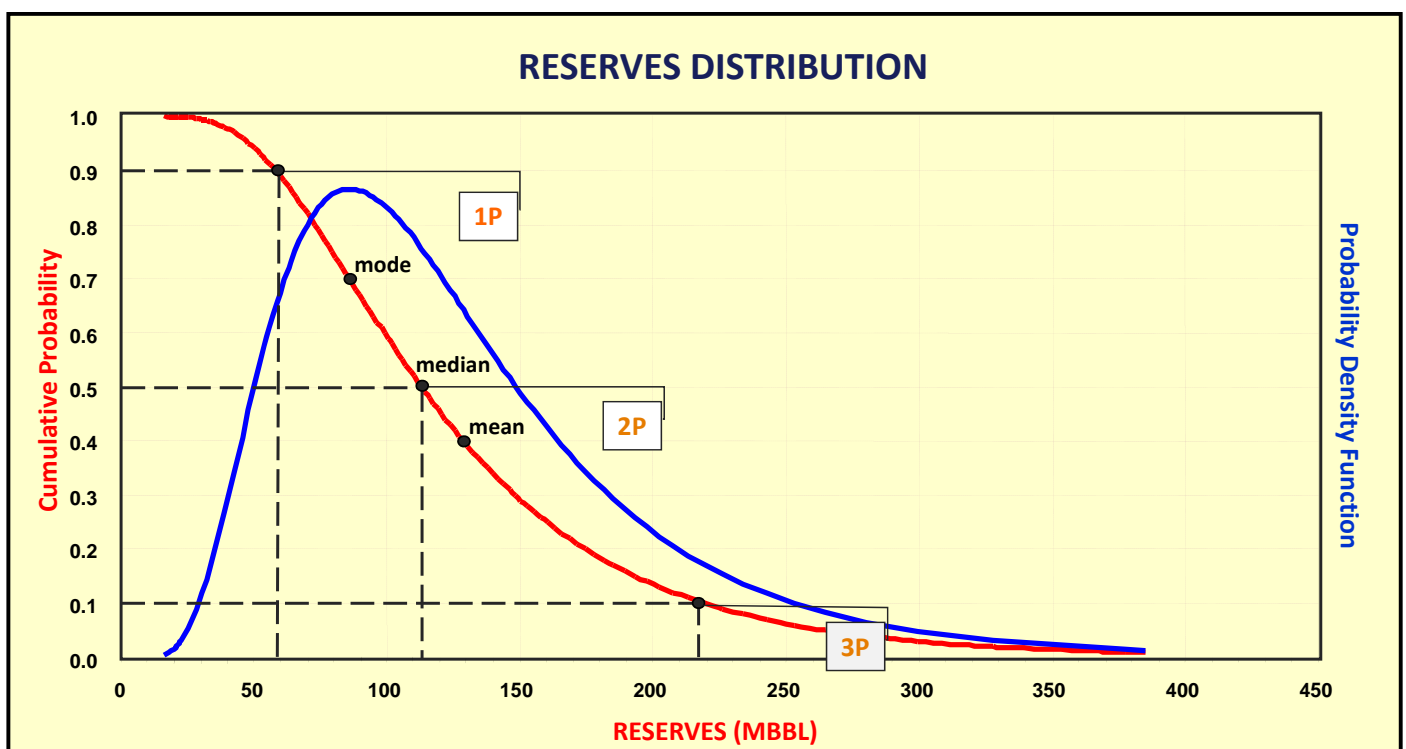
The volume of oil and gas reserves is given by the product of fundamental physical variables
(rock volume, porosity, oil saturation, recovery factor, etc.)

Given the uncertainties provided by measurements, each parameter is described by a probability distribution



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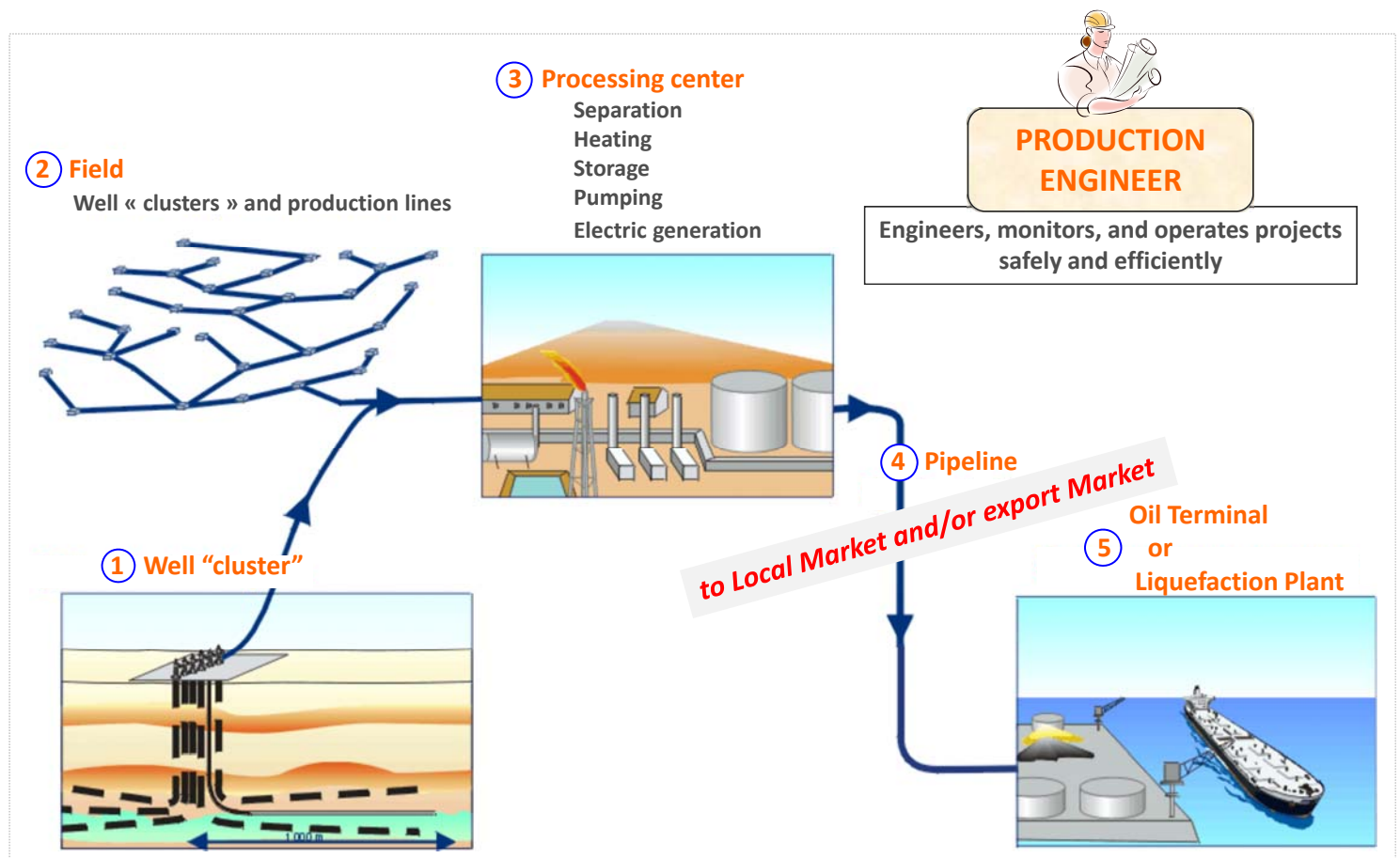
Reserves distribution: a log-normal law



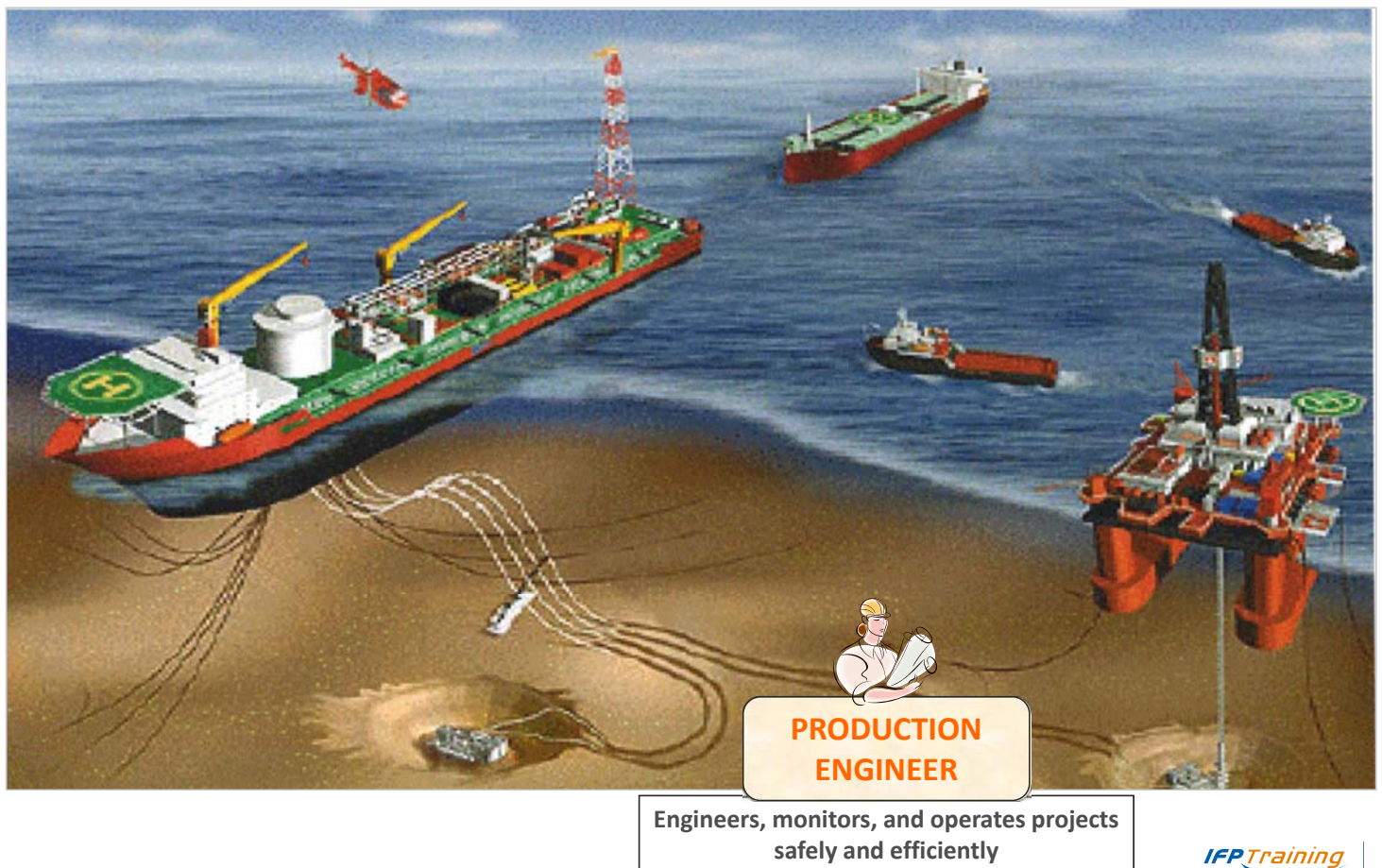
$$\text{Mean Reserves} \cong 0.3 P10 + 0.4 P50 + 0.3 P90$$

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Onshore development scheme



Offshore development scheme



INVESTMENT = CAPITAL EXPENDITURES (CAPEX)

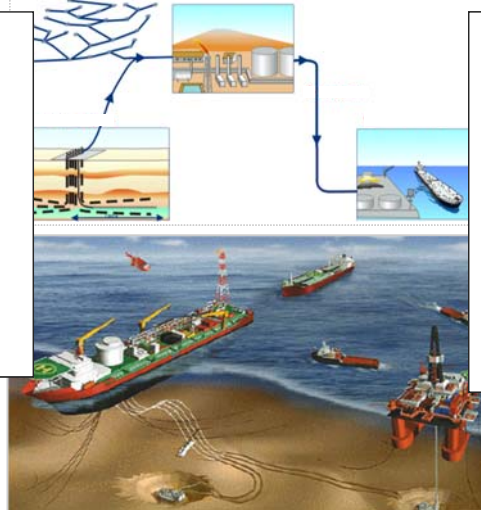
Wells
Offshore structures
Treatment facilities
Pipelines (export and gathering)
Compressors
Onshore terminals and other facilities
Access roads, ...

OPERATING EXPENSES (OPEX)

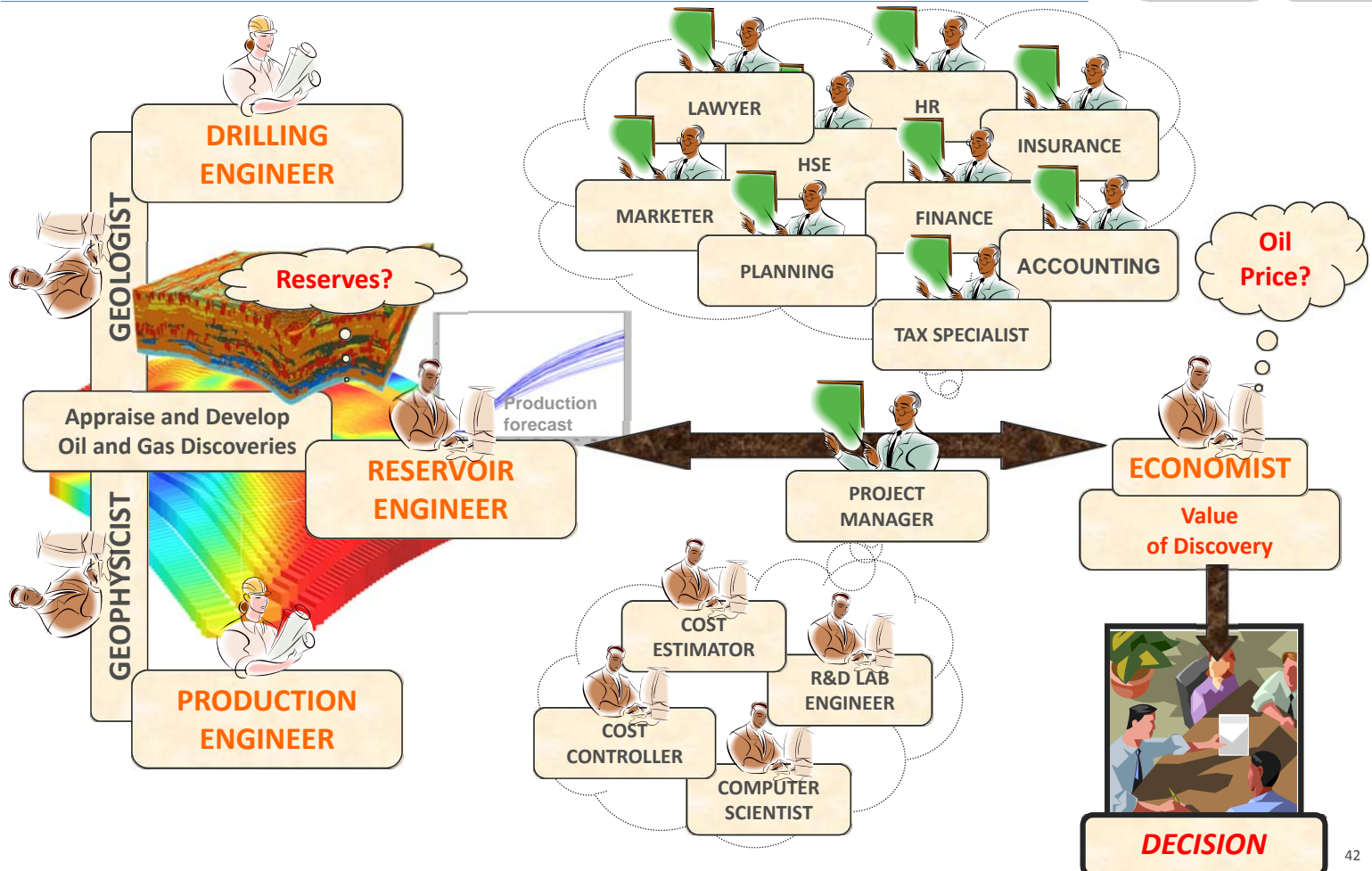
- Consumables
- Personnel
- Logistics: boats, helicopters, vehicles, etc.
- Energy
- Transportation of products (tariff)
- Maintenance
- Upgrades, ...

ABANDONMENT COSTS

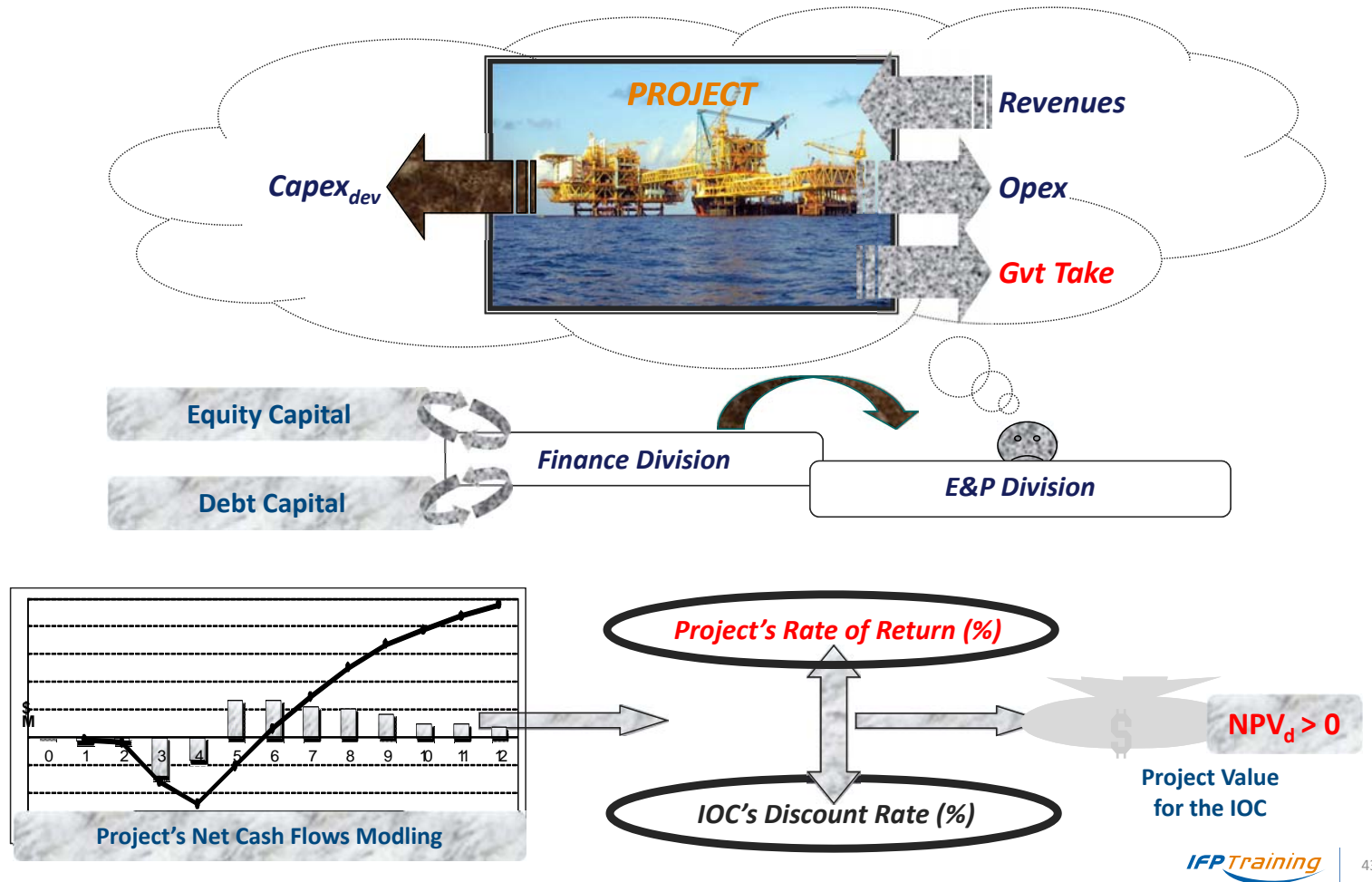
- Topsides dismantlement
- Treatment of wastes
- Wells, plug and abandon
- Pipelines decommissioning or dismantlement
- Dismantlement of sub-sea structures



Development / Value creation at experts meeting points



Financing, value creation and investment decision



Forward investment analysis for a development project

Question: invest or not in the development of a discovery?

- ❑ After discovery, the Value of the field for the Oil Company is the **Net Present Value (NPV_d)** resulting from development
- ❑ The evaluation excludes **past cash flows** in exploration but includes exploration cost in the cost recovery or depreciation according to the fiscal terms of the patrimonial contract.
- ❑ This **Net Present Value** will depend on the **Scenario** considered:
 - Development Plan
 - Economic Assumptions
 - Contractual Framework

What does an economist need to model and evaluate the economics of a project?

► Technical Data

- Capital Expenditures (exp., app., dev., tangible, intangible, schedule, currencies)
- Operating Expenses (fixed, variable, schedule, currencies)
- Abandonment or Decommissioning Cost (schedule, currencies)
- Production Profile (annual volumes or quantities)

► Economic Assumptions and Contractual Framework

- Brent or WTI Price Scenarios, Crude Oil Quality Differentials
- Natural Gas Price Scenarios or Formulas
- Pipeline Tariffs
- Inflation Rate, Escalation Factors, Exchange Rates
- Fiscal Terms (profit sharing, royalty, taxes, provisions, carry, depreciation, uplift ...)

► Discount Rate

Fixed by the Management and linked to:

- Company's Cost of Capital Employed, and
- Management's Appreciation of Risk

Cost and value of information

Scenario: for the development of a discovery, given the uncertainties regarding the reserves expressed as "40% chance for large reserves and 60% chance for small reserves", the project team has come out with three strategies:

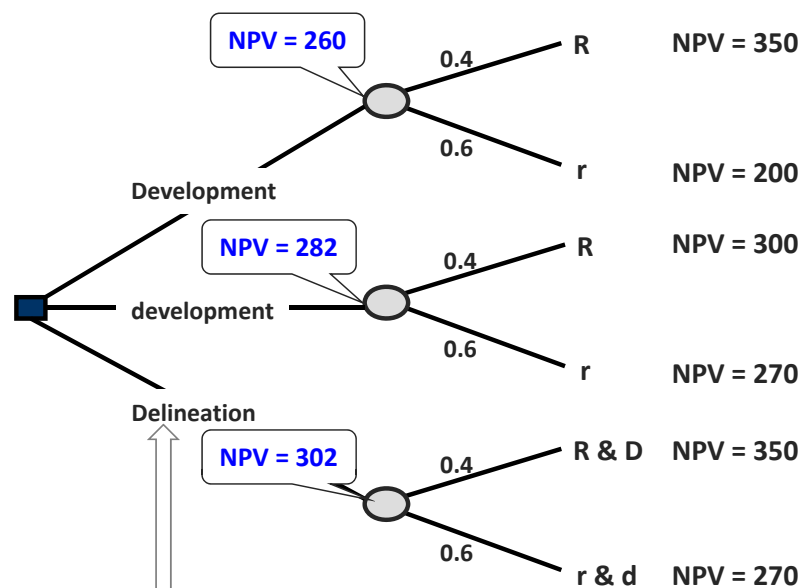
Strategy 1: Invest immediately in a large structure which will allow starting producing rapidly with a relatively high plateau.

Strategy 2: Invest immediately in a small structure which will allow starting producing rapidly with a relatively small plateau.

Strategy 3: Continue the appreciation of the field with one more delineation well which will provide more information on the reserves. This will allow choosing the best architecture: the small structure in the case of small reserves, or a large structure for large reserves with a higher plateau.

Decision Tree Analysis allows one to choose the best strategy and derive the maximum amount one would be willing to pay for the delineation well under consideration.

Decision Tree Analysis



What is the expected value of information and its maximum acceptable cost?

Expected value of perfect information

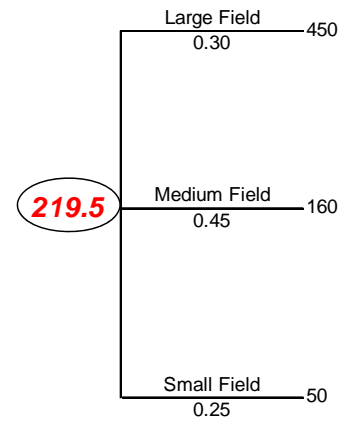
Exploration drilling on a prospect has resulted in a commercial discovery and facilities need to be selected.

Based on the possibility of three different field sizes, three different sizes of facilities can be installed.

Expected payoff without additional information

Field Size	Probability	NPV (MM\$)		
		Size A	Size B	Size C
Large	0.30	290	350	450
Medium	0.45	90	210	160
Small	0.25	60	35	50

EMV	142.5	208.3	219.5
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Expected payoff with perfect information

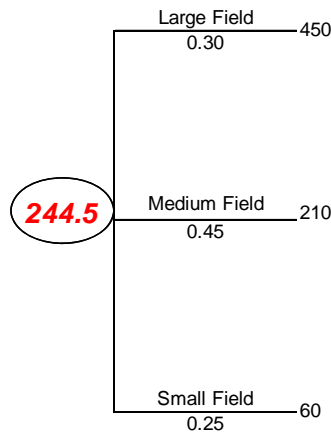
Field Size	Probability	NPV (MM\$)		
		Size A	Size B	Size C
Large	0.30			450
Medium	0.45		210	
Small	0.25	60		

EPPI	244.5	15.0	94.5	135.0
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EVPI = EPPI - EMV =	25.0
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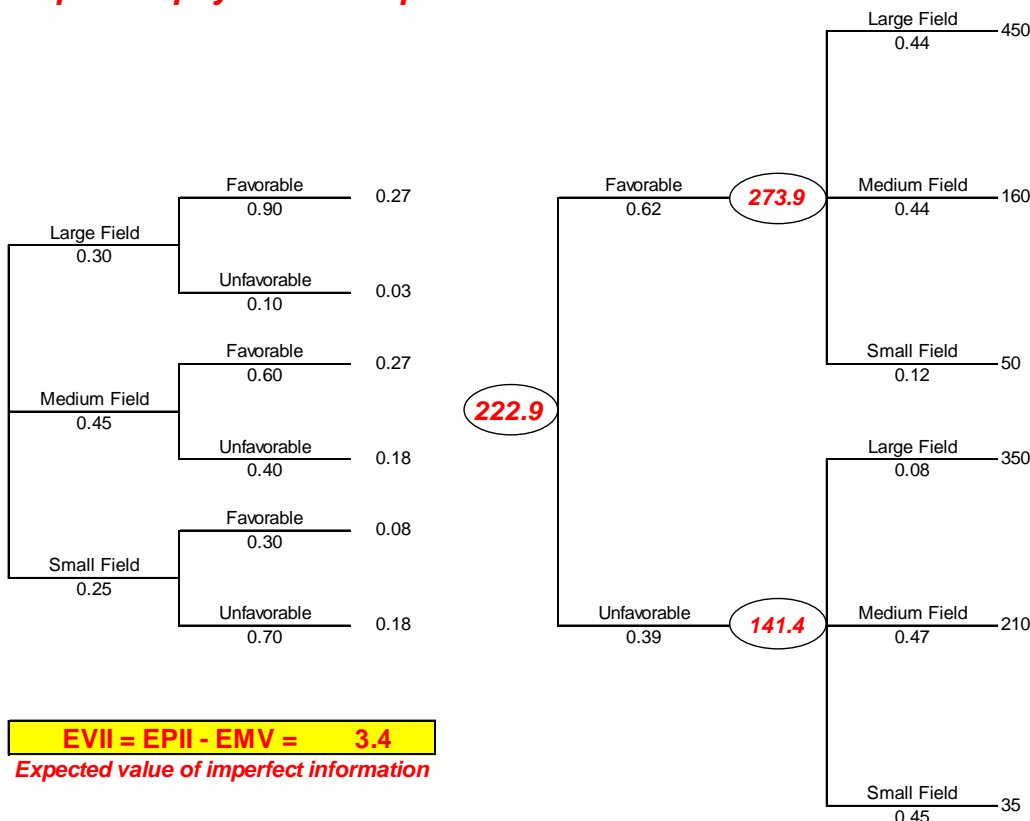
Expected value of perfect information

maximum amount of money one would spend to acquire this perfect information



Expected value of imperfect information

Expected payoff with imperfect information from delineation



$$EVII = EPII - EMV = 3.4$$

Expected value of imperfect information

Delineation favorable

Field Size	Posterior Probability	NPV (MM\$)		
		Size A	Size B	Size C
Large	0.44	290	350	450
Medium	0.44	90	210	160
Small	0.12	60	35	50

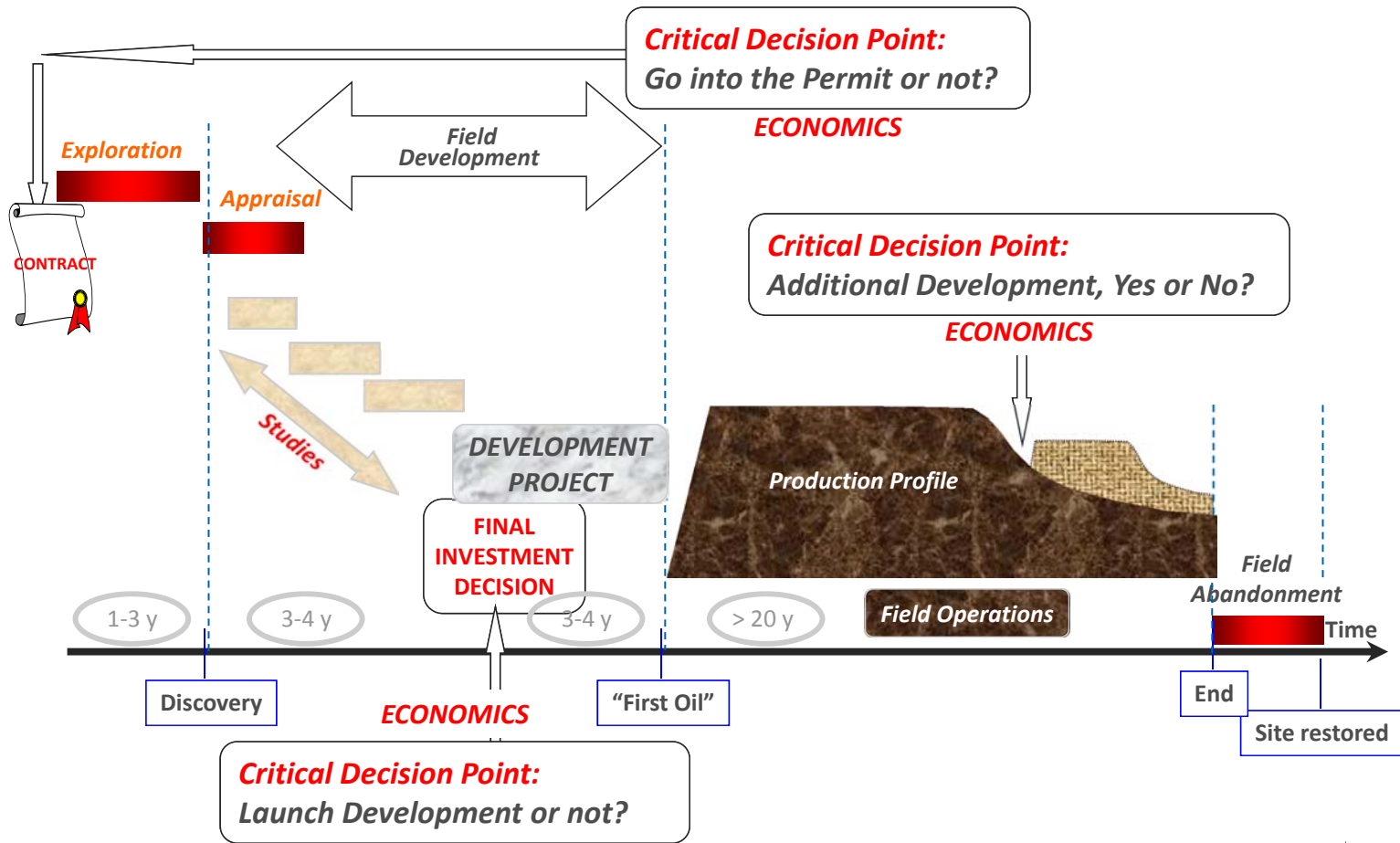
EMV	174.1	250.1	273.9
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Delineation unfavorable

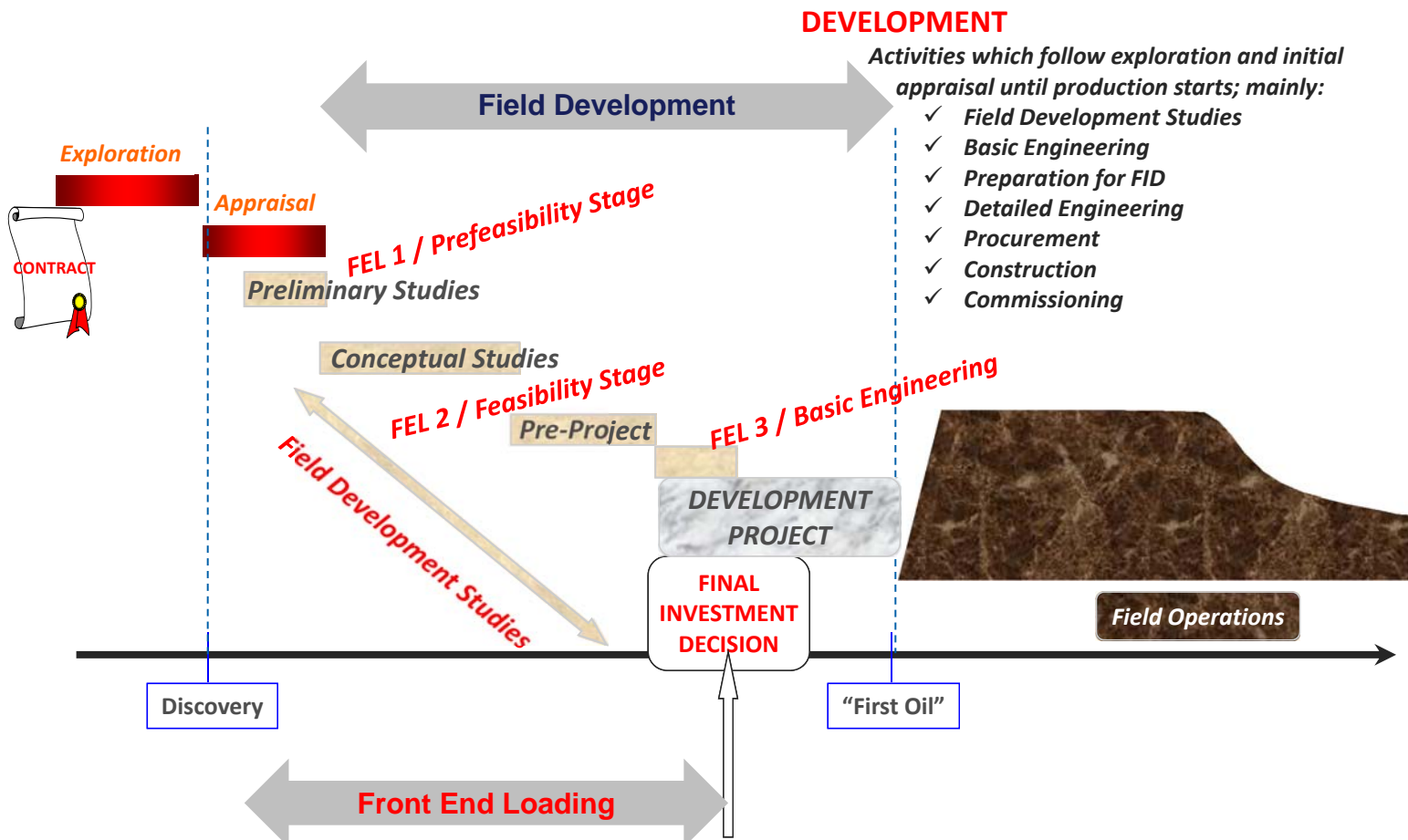
Field Size	Posterior Probability	NPV (MM\$)		
		Size A	Size B	Size C
Large	0.08	290	350	450
Medium	0.47	90	210	160
Small	0.45	60	35	50

EMV	91.9	141.4	132.6
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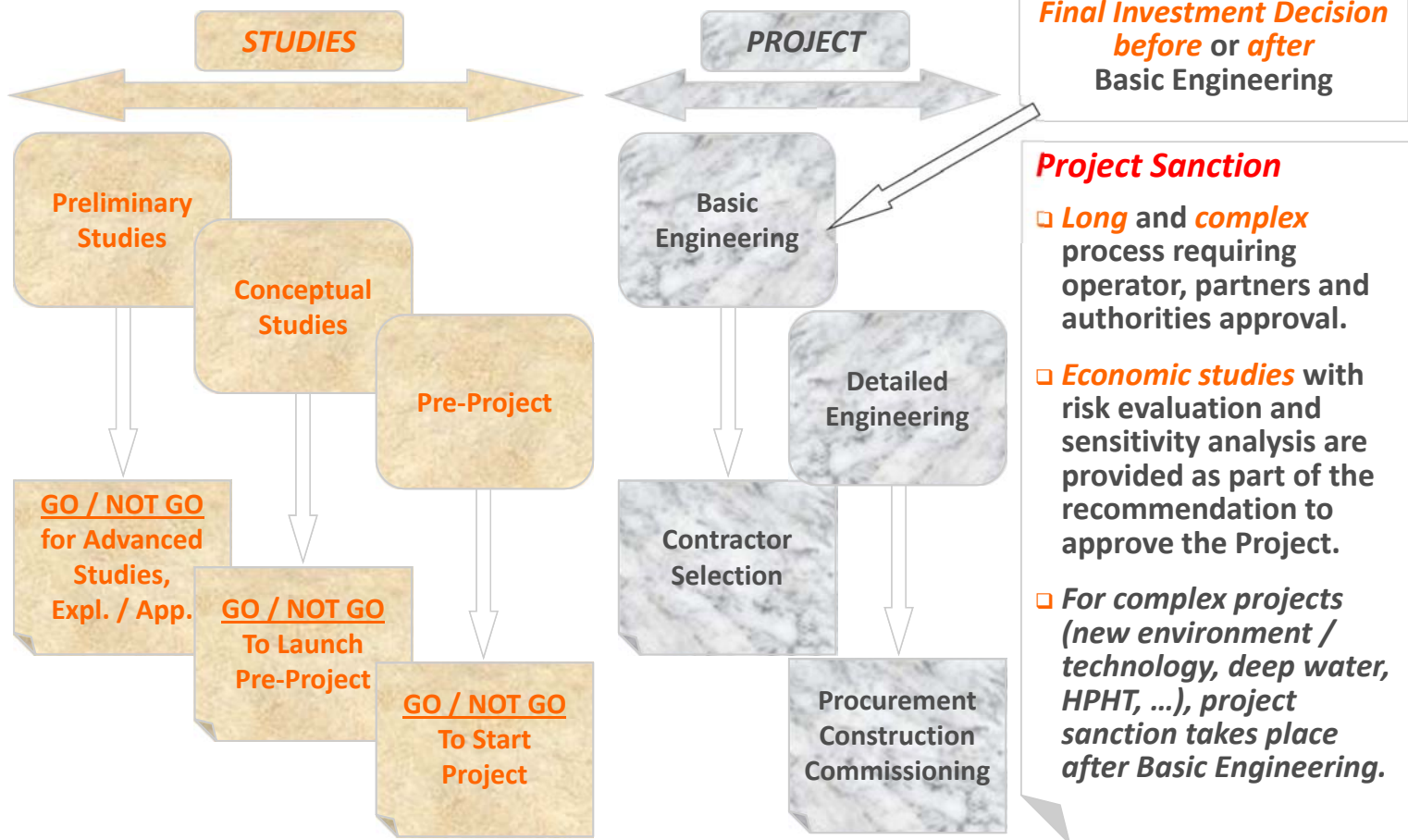
Critical decision points along the E&P chain



Front-End Development in the field development process



Various steps in the field development process

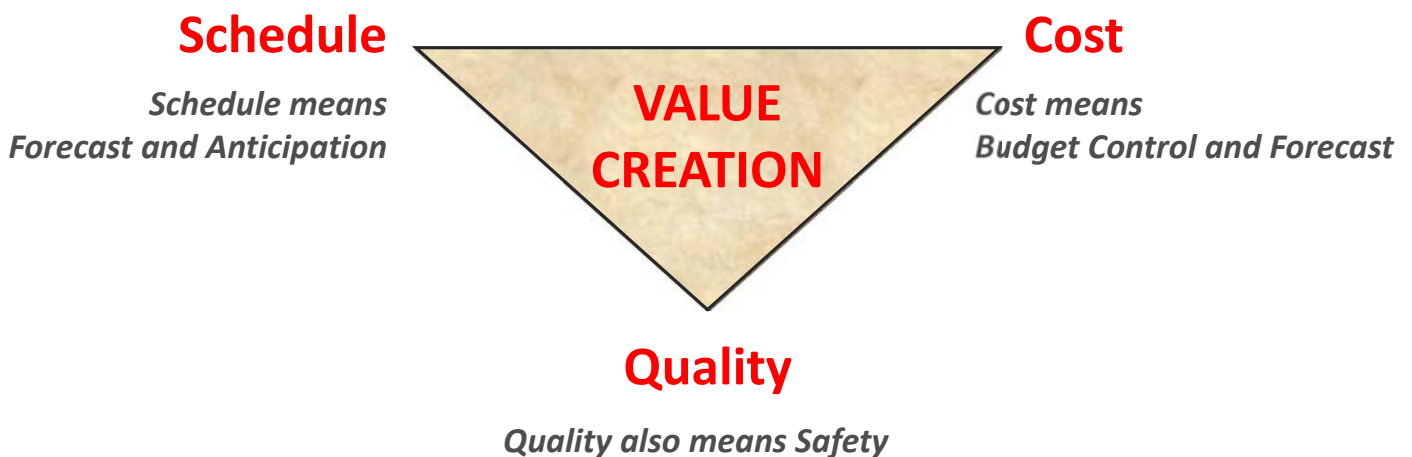


Project management

A project is a global approach to achieve a defined objective

A project is a method and a tool designed to control an industrial investment

A project is based upon an economic reality



The project team has to manage all three aspects

E&P value chain: 3 key processes



*requires an optimal contribution from all those involved along the value chain
in the three processes : **Evaluation, Approval and Management***



Specialists

geologists, geophysicists, reservoir engineers,
production engineers, drilling engineers,
economists, tax specialists, negotiators,
lawyers, marketers, ...

Managers

project management, safety, environment,
finance, accounting, planning, cost control,
legal, insurance, human resources,
administration, ...

*A clear view of the overall picture of the E&P value chain
is essential for everyone.*

Risk, and again risk ... Safety, and again safety

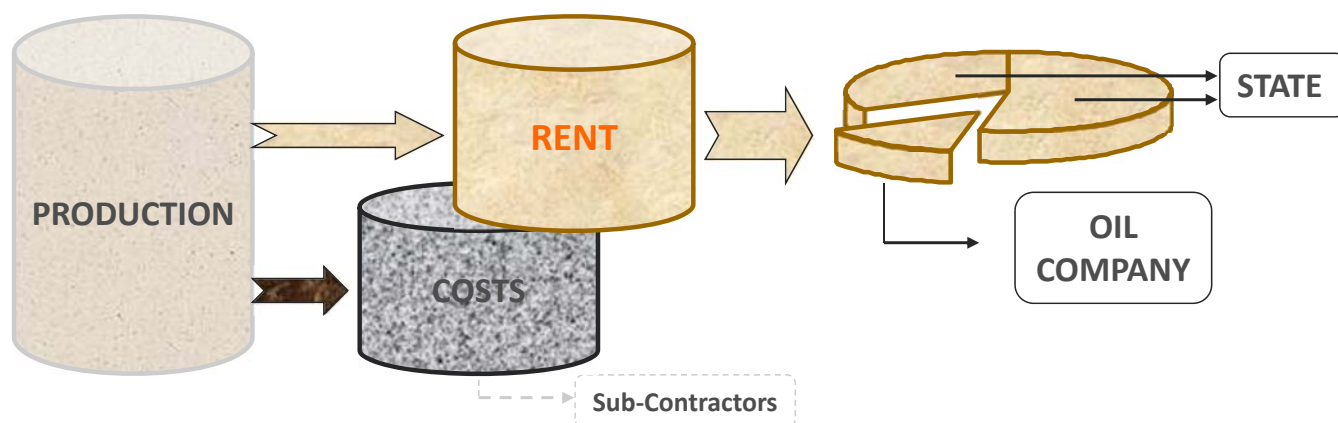


Fundamental Contractual and Economic Aspects

Bottom line of oil and gas contracts is sharing the value

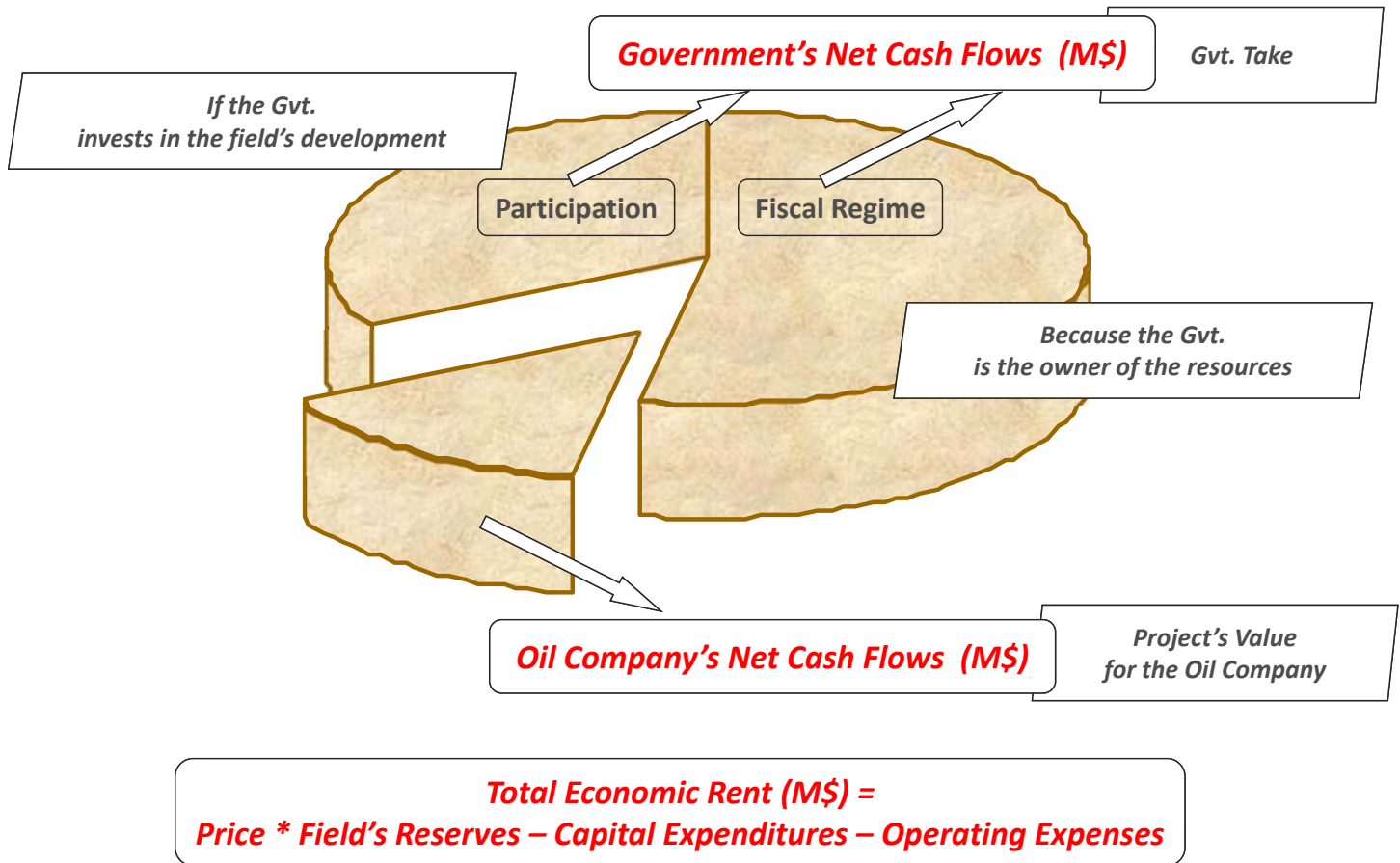
At the center of the Host Countries - Oil Companies relationship, the concept of the sharing of the oil rent

$$\text{RENT} = \text{REVENUES} - \text{COSTS}$$



The main point of any oil contract is to define the sharing methodology.

Sharing the value / a project full cycle evaluation



State's intervention in exploration-production

Two possible types of intervention of the State who is the holder of the mining rights:

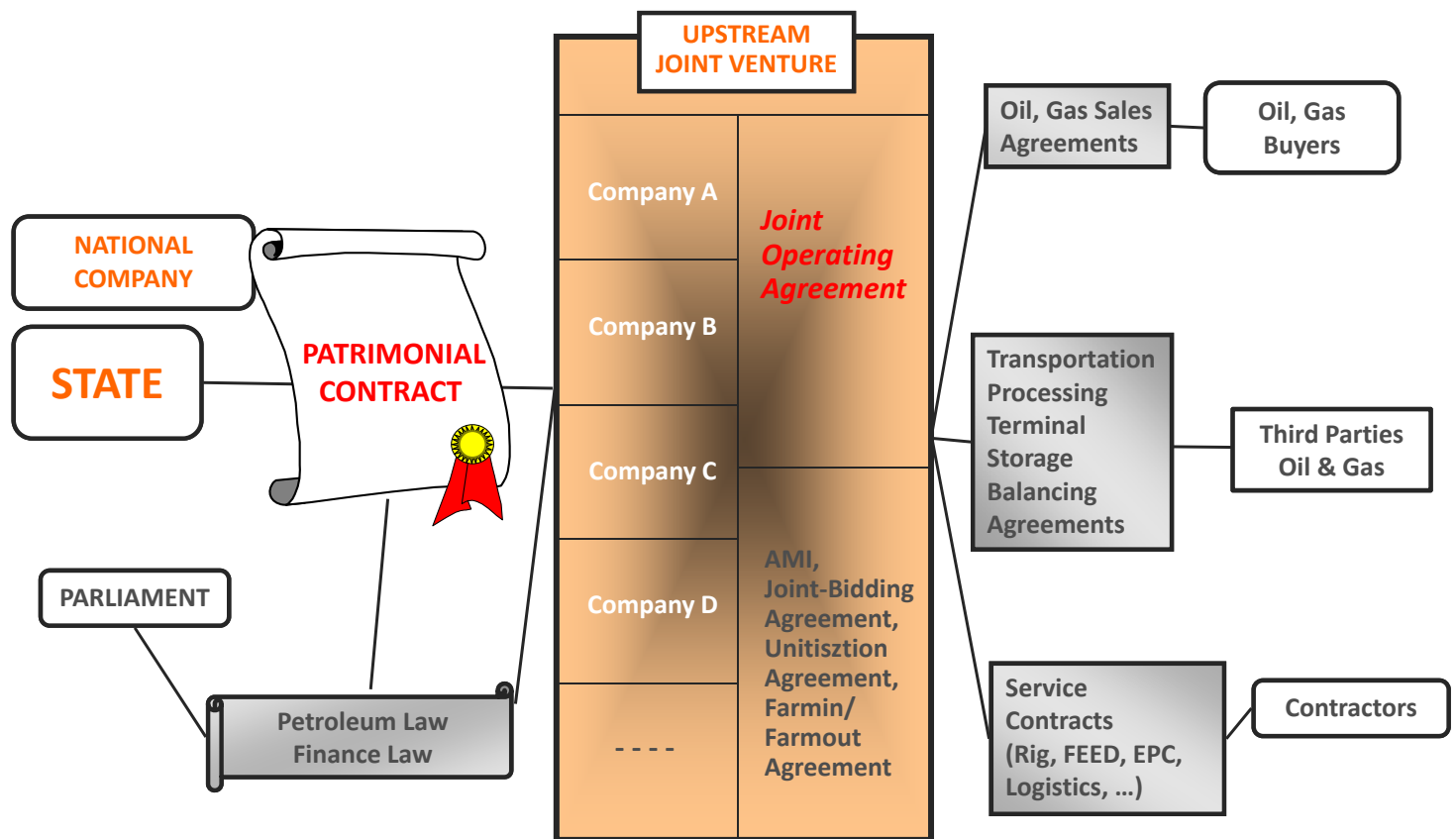
- *State develops its own natural resources through national companies, exerting or not a monopoly, or service companies within the framework of technical assistance contracts.*
- *State chooses the company who will carry out the operations of exploration and exploitation, within the legal regime in force:*

Concession Contracts Regime

Production Sharing Contracts Regime

Risk Service Contracts Regime

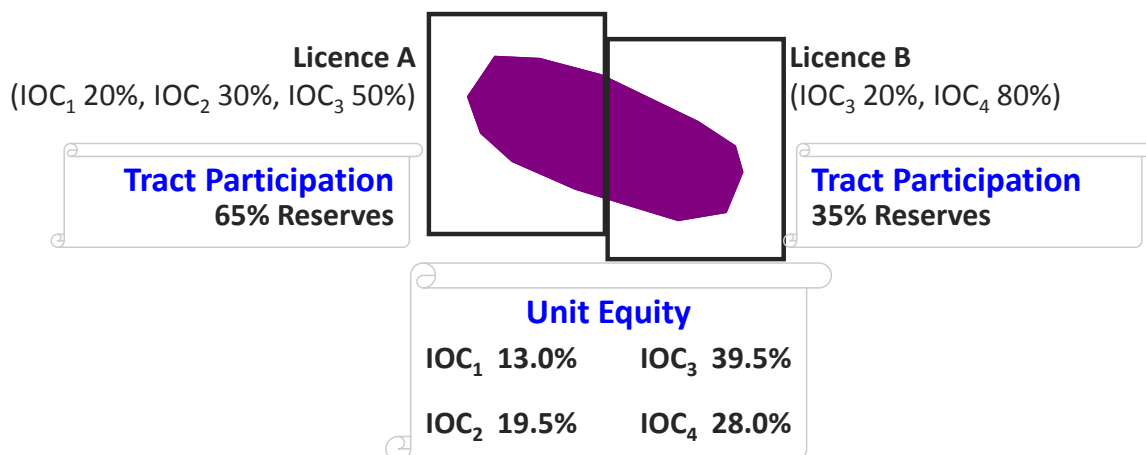
Overview of the contractual framework of E&P activities



Unitization agreement

Development and production, as a single unit, of a reservoir that straddles two or more permits or countries, through

a "unitized joint venture" with a single operator.



- Optimize the development of the reservoir
- Reduce capital costs and operating costs
- Improve the ultimate recovery of reserves

► *Patrimonial Agreement*

(+ accounting procedure)

- parties: State and oil companies.
- legal, financial and tax framework to explore and exploit an area (permit) awarded by the State without result obligations.

► *Association Agreement*

(+ accounting procedure)

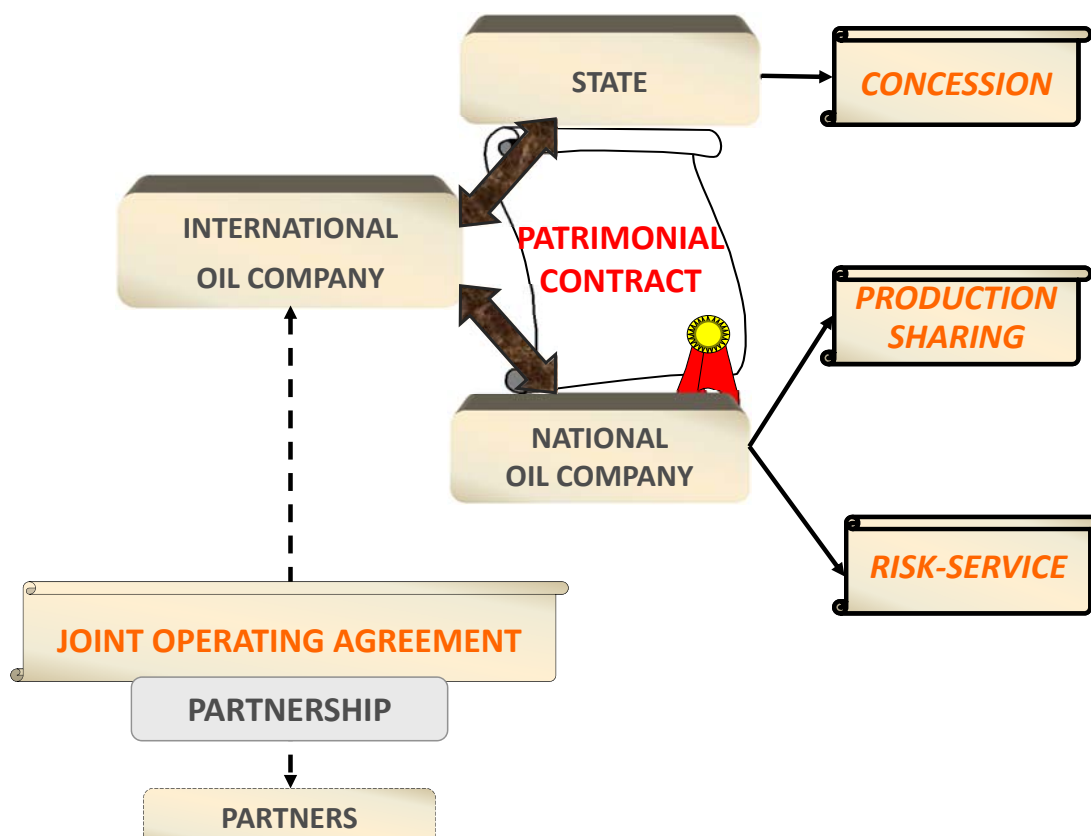
- parties: oil companies or oil companies and the State in the case of State participation .
- legal framework defining the decision process and rules for carrying out operations (operator and definition of the parties' responsibilities).

► *Technical Service Contracts*

(+ implementation conditions and payment conditions)

- parties: operator and service companies.
- supply of a remunerated service: contract with result obligations.

Patrimonial Contracts



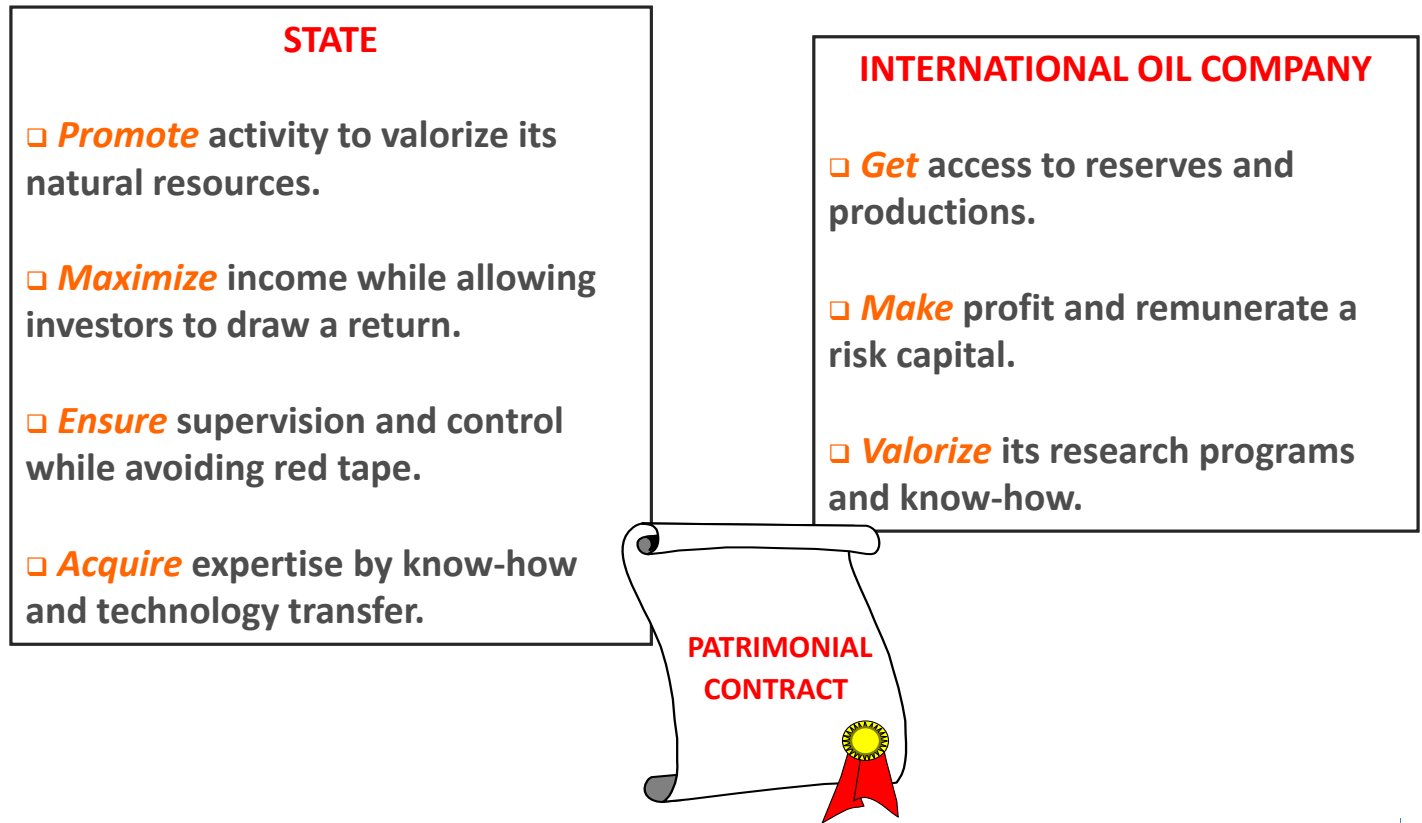
- JV formula corresponds to *a sharing of costs and production* according to each associate participating interest, not a sharing of income.
- Each associate is *separately* subject to taxation.
- Particular provisions define *the rights, advantages and obligations applying to the State* as a partner (participation date, financing, etc.).
- These provisions *differentiate an Association Agreement with the State from the usual JOA between several oil companies* which join to be co-holders of mining titles or co-signatories of an oil contract.

Joint operating agreement

The JOA defines the provisions which govern the relationship of all the joint venture partners in great detail.

- *Operating committee* decides *work programs and budgets* according to *a majority vote*.
- Oil operations are led by an *Operator* (who can be an "operating company" created by the partners).
- Partners pay the *cash calls* prepared by the Operator to cover the expenditures to be made within the framework of the work programs.
- Each partner has the *right* and the *obligation*, to *take* and *market* a *share of the production* in proportion to its *participating interest*.

Objectives of the major players in the upstream sector



National oil companies' role

► Two roles for the NOCs

- **Represent the State as a public authority**
 - control and supervision of the oil operations,
 - uplift of the State's share of production.
- **Hold a direct interest in the operations as a partner**
 - starting from the date of signature of the contract, or
 - starting from the date of a commercial discovery.

► Trend of these past few decades

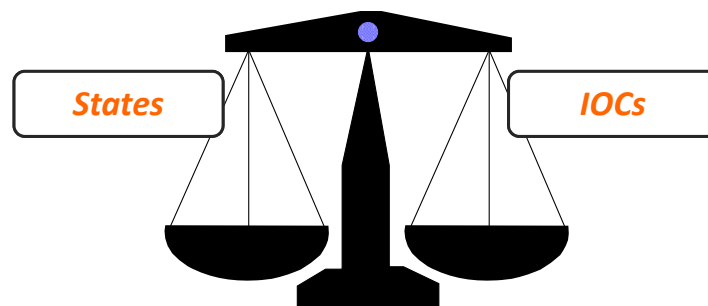
- **Separation** of these two roles, control being taken by an **agency** and even
- partial or total **privatization** of the national oil company.

Motivations for State participation

- to have access to an **additional share** of production.
- to increase the **State revenues** by having a direct participation in the operations profits given the financing of a share of costs.
- to acquire **know-how** in the oil business by participating in the decision process with its analysis, work programs and budgets.
- in the short term, to obtain a better **control** of the oil operations and expenditures.
- in the long term, to take charge of the exploitation of some of the national resources by becoming oil **operator**.

What is at stake?

Upstream: Global International Market with Strong Competition



Attractiveness of the basin to explore?
Oil market situation?

Fair and Stable Fiscal and Contractual Framework

necessary incentives to face **a very high risk** and take into account **the wide range of expected costs**

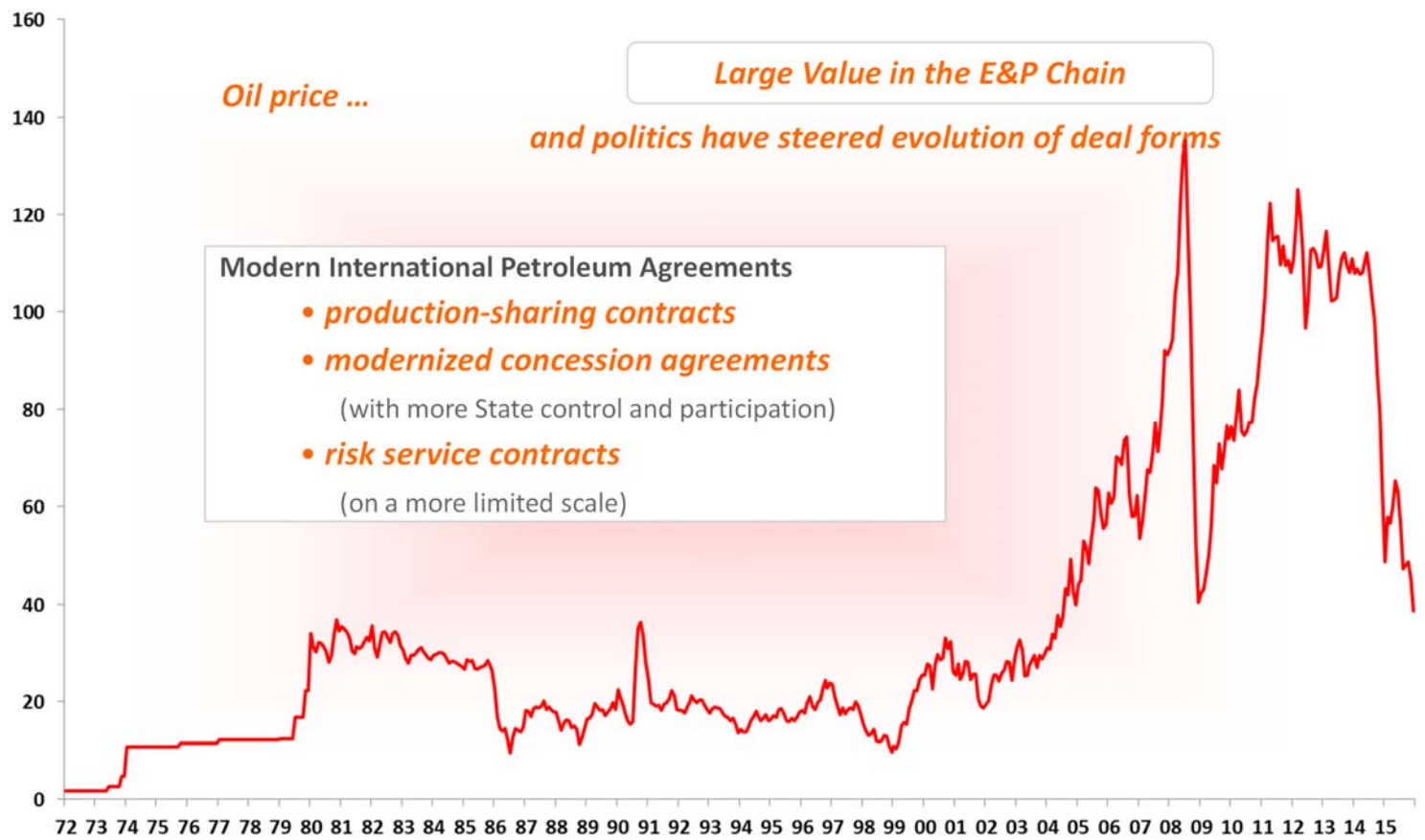
**PATRIMONIAL
CONTRACT**



WIN-WIN SITUATION

will lead to a satisfactory level of exploration-production activity

Evolution of international petroleum agreements



Concession contract

□ **State** assigns its rights to explore and exploit underground resources to the IOC.

□ **IOC (Licensee or Contractor)**

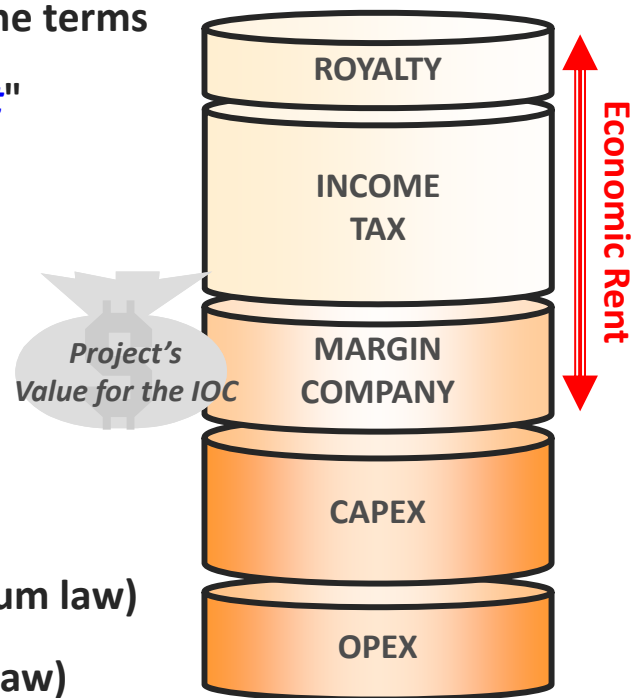
- undertakes and finances the exploration at its own risk.
- if the exploration is successful, it decides on development and production:
 - owns the production (hydrocarbons at the surface),
 - owns all the facilities financed,
 - pays royalties and taxes to the State.

□ *State Participation*

can be inserted in the contract with the terms defined in an "*Association Agreement*"

□ *State revenue sources*

- bonuses
- surface rental
- royalty on production
- petroleum income tax (petroleum law)
- corporate income tax (finance law)



Production sharing contract

□ **State** keeps its mining rights or delegates its rights to the *NOC* that contracts an *IOC* to exploit the reserves.

□ *IOC (Contractor)*

- undertakes and finances the exploration at its own risk.
- after the decision to develop a discovery is made, it undertakes and finances development and production:
 - is reimbursed for its expenses by a share of production called cost oil.
 - is remunerated by a share of the remaining production after cost oil has been deducted, the profit oil.

□ **NOC** owns the facilities and may take part in the development phase.

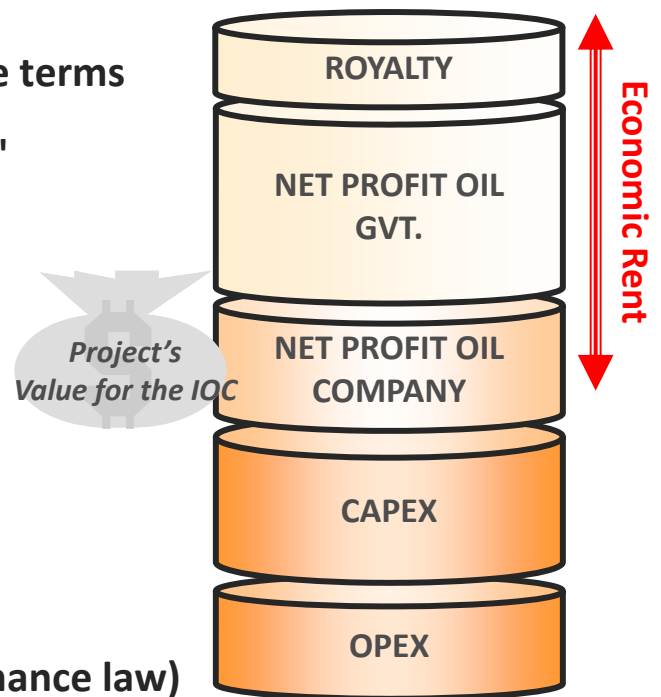
Production sharing contract

□ State Participation

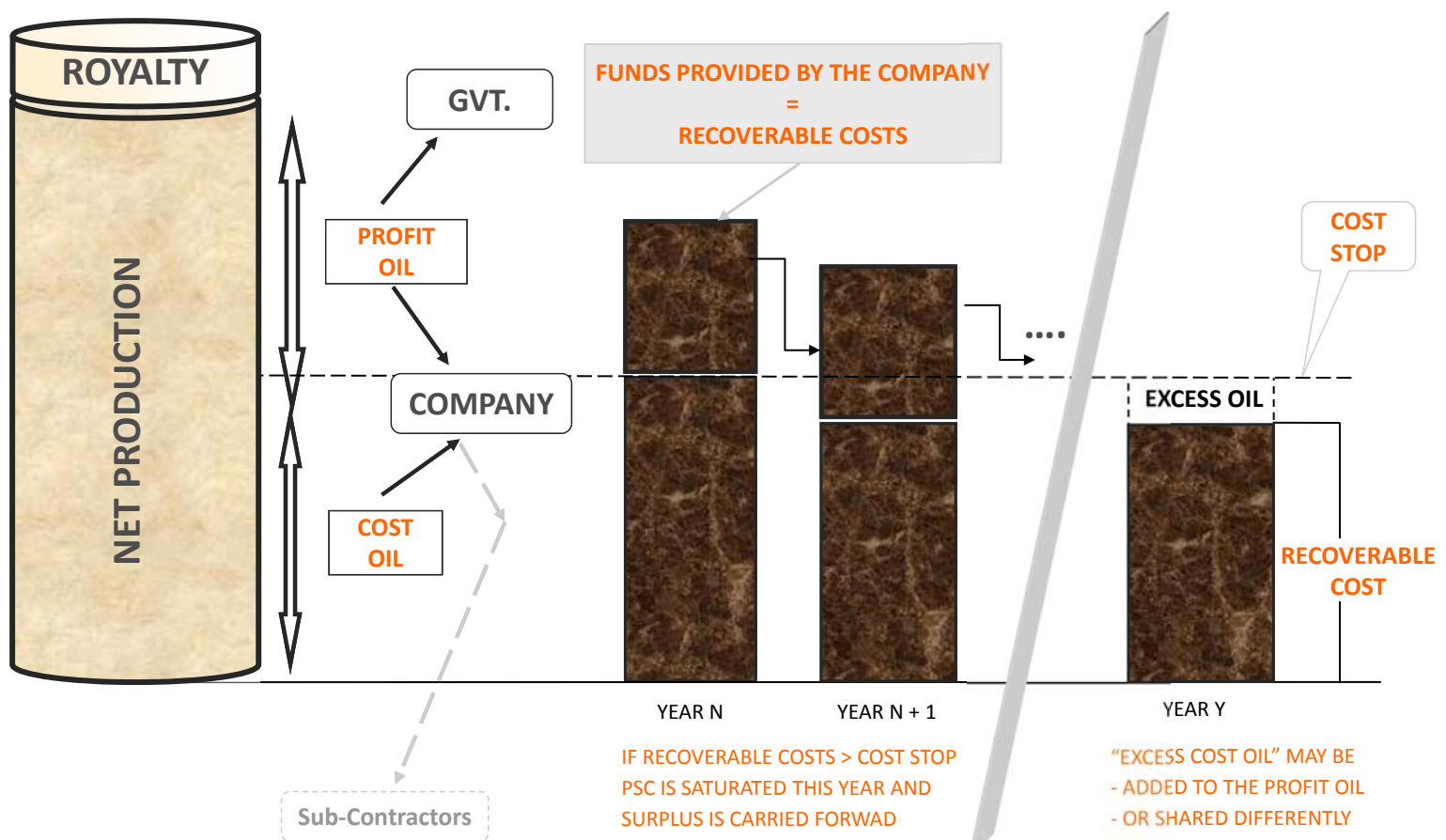
can be inserted in the contract with the terms defined in an "**Association Agreement**"

□ State revenue sources

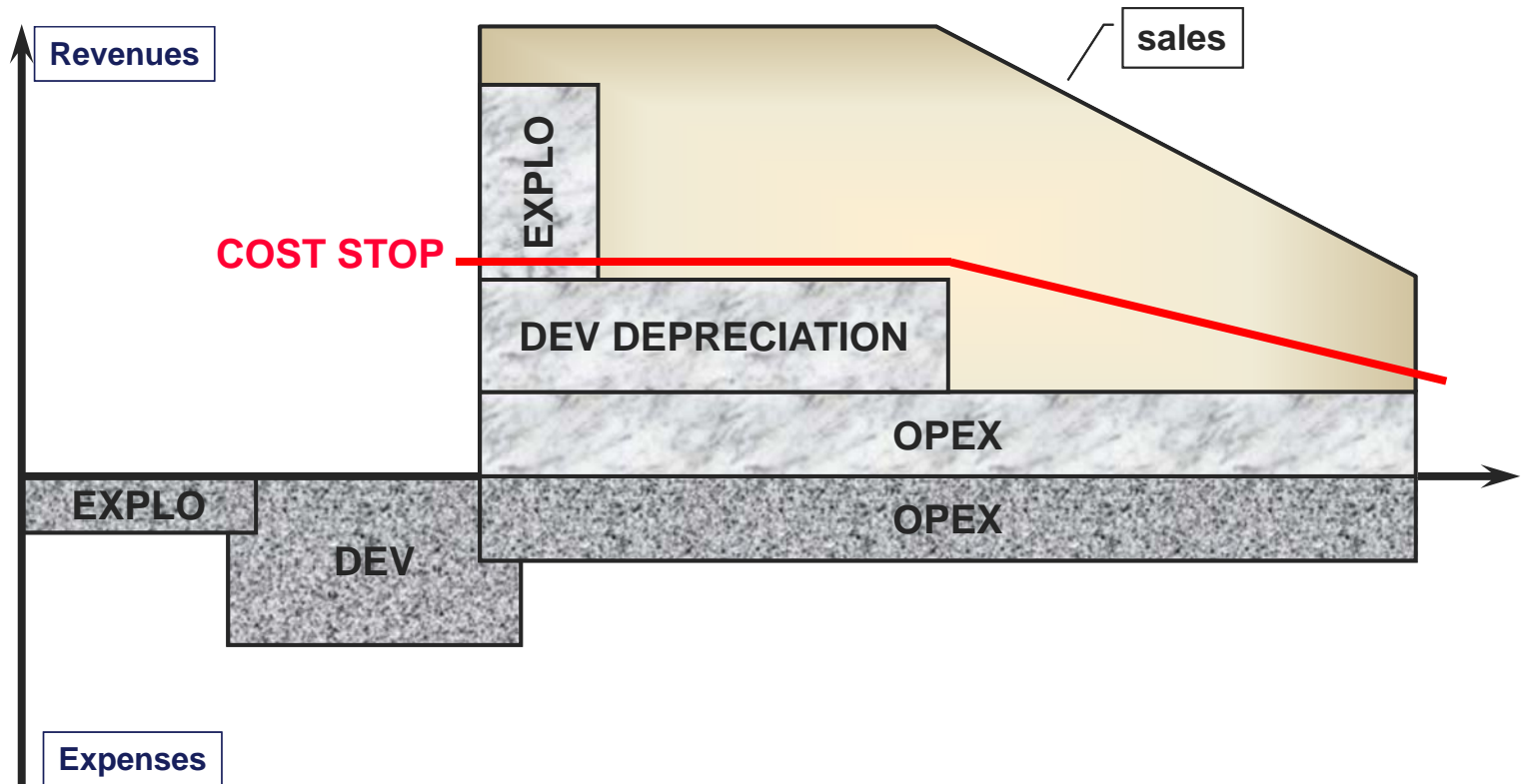
- bonuses
- royalty on production
- a share of profit oil
- income tax (petroleum law or finance law)



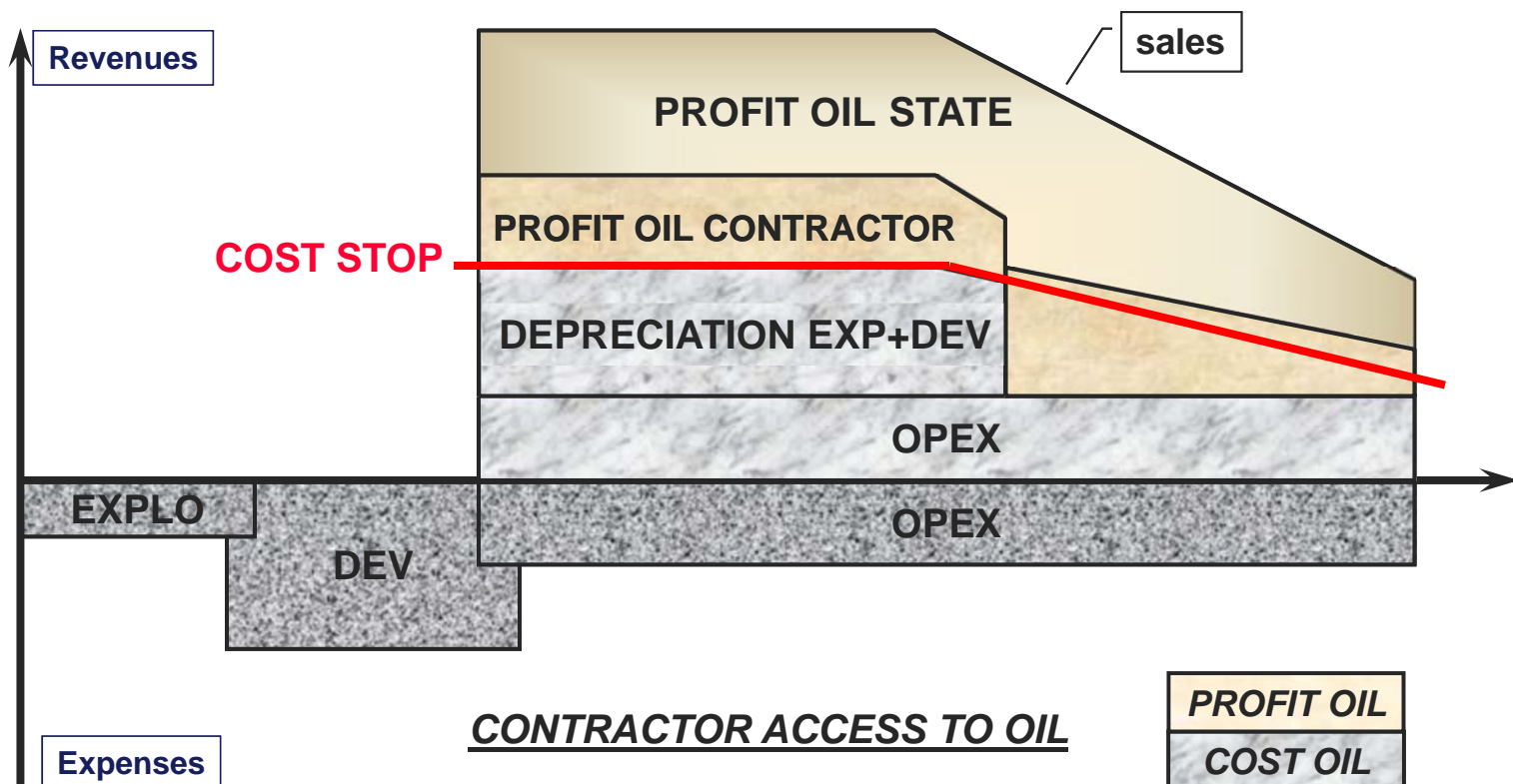
Production sharing and cost recovery process



Production sharing and cost recovery process

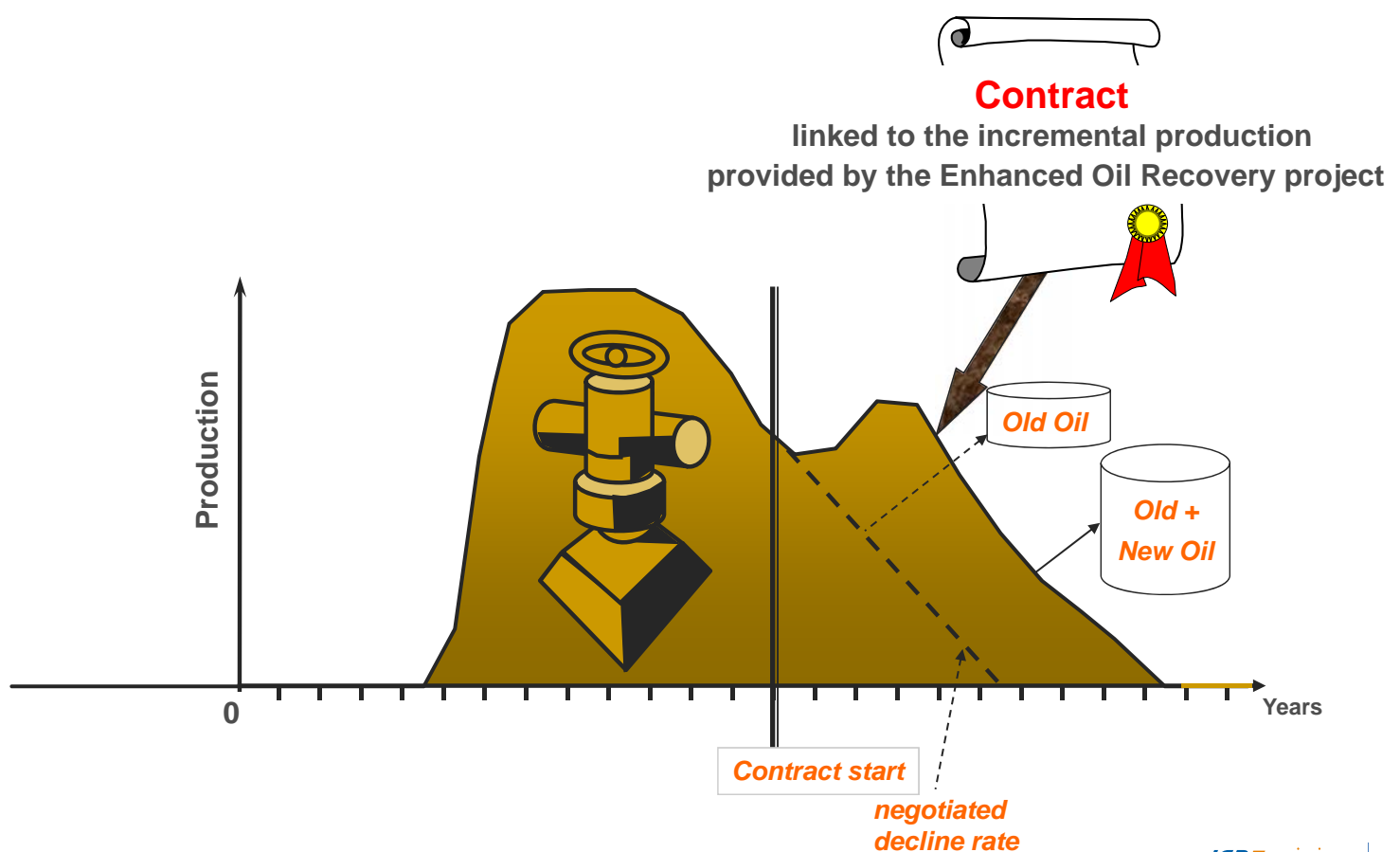


Production sharing and cost recovery process



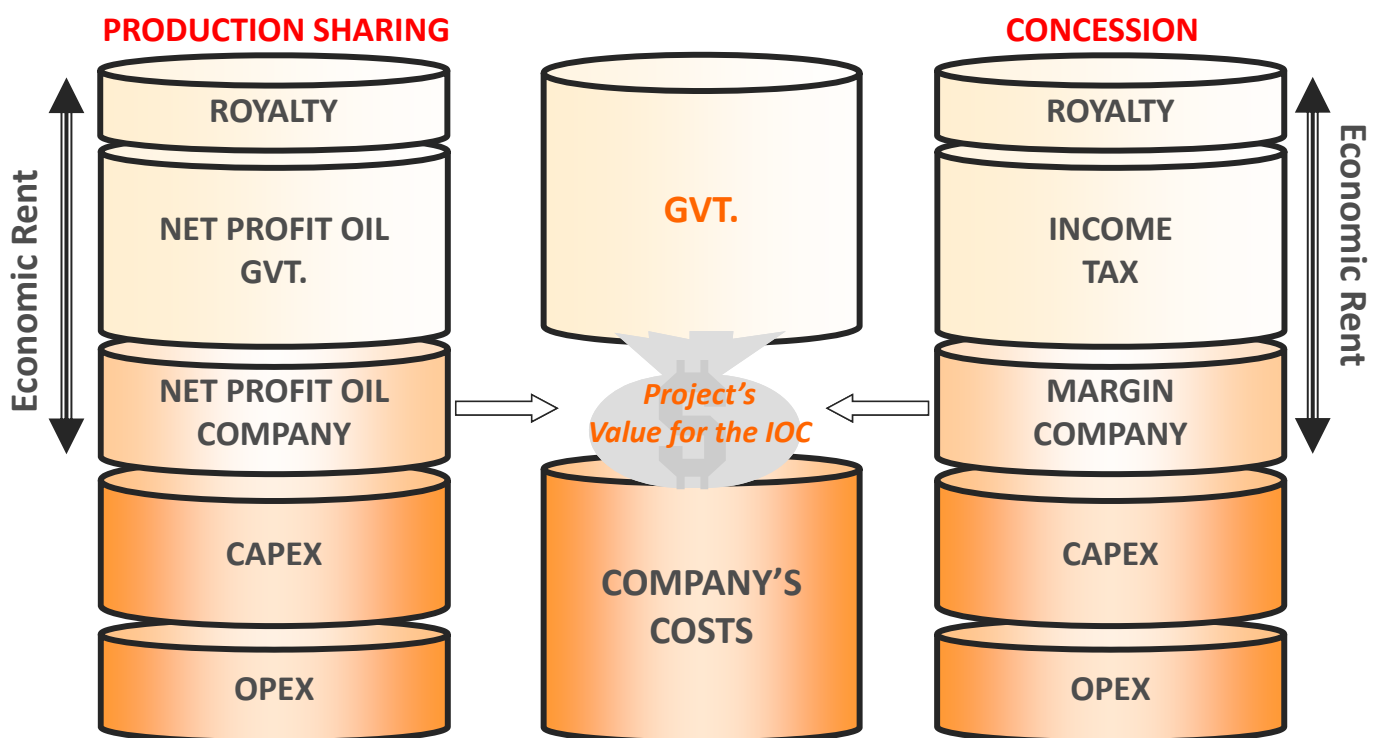
- ❑ **IOC** carries out exploration, or take on the development of an oil field, **at its own risks and on behalf** of the **NOC**.
- ❑ **IOC** carries out the operations under the **control** of the **NOC** who owns the facilities.
- ❑ **NOC** can become **Operator** starting with development or production.
- ❑ **Refunding** and **remuneration** based on performance.
- ❑ **Production** belongs to the NOC, and the IOC is (in some cases) allowed **to buy a fraction** under agreed conditions.

EOR contracts



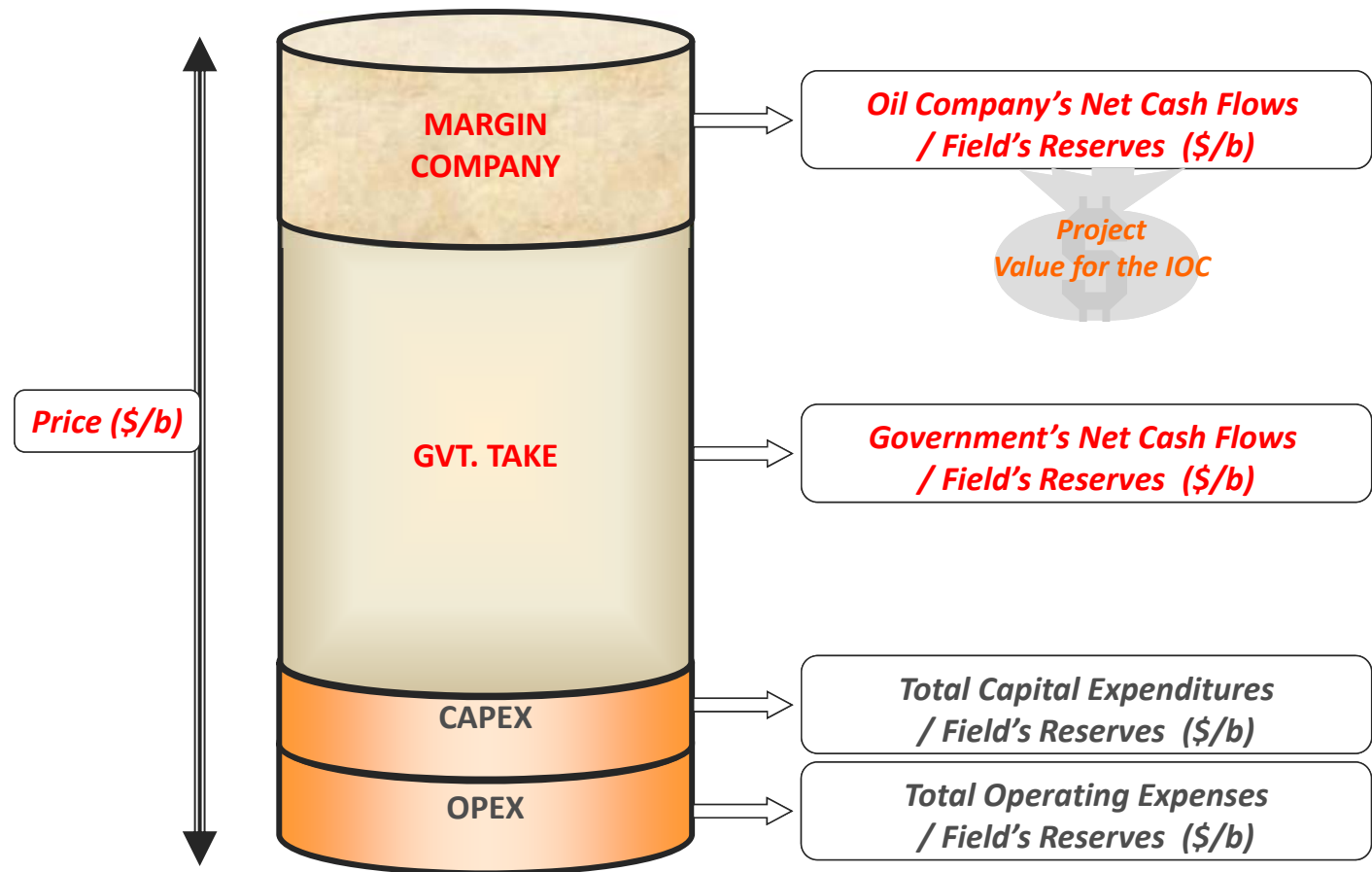
- ❑ **Service contracts without risk** (*pure-service contract*): technical assistance or cooperation agreement.
- ❑ **IOC (Contractor)**
 - does not take any risk and does not finance work directly.
 - receives a remuneration (fee), for the services provided.
 - State commits to ensure a minimal revenue (\$/b) to the contractor regardless of the crude oil sale price (e.g. by adjusting through tax the margin to give a fixed final margin).
- ❑ Technical assistance contracts relate primarily to old fields **exploitation work** and sometimes to **development work**.
- ❑ Some technical assistance contracts allow the IOC to **purchase part of the production**.

Bottom line of oil and gas contracts is sharing the value



The State is always the owner of the hydrocarbons reserves underground, and the IOC supports all the financial risks, and supplies the funds, the equipment, the know-how and the necessary personnel.

Sharing the barrel / a project full cycle evaluation



Concession / fiscal system structure

Gross Revenues = Total Oil and Gas Revenues

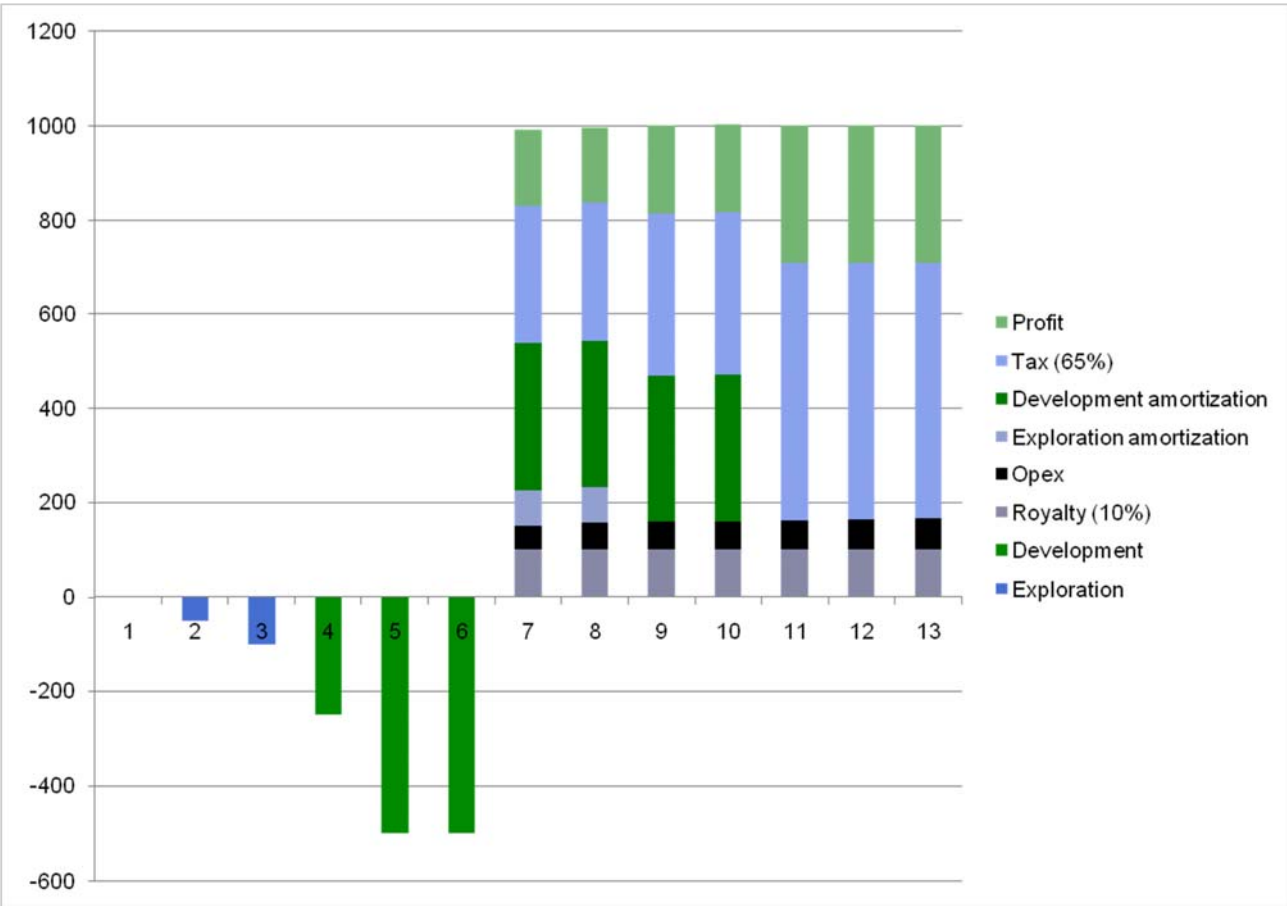
Royalties = Gross Revenues * Royalty Rate (%)

Taxable Income = Gross Revenues – Royalties

- Operating Costs – Depreciation Charges
- *Investment Credits or Uplift* – *Intangible Capital Costs*
- *Financial Charges* – *Tax Loss Carry Forward*
- *Abandonment Cost Provisions* – *Bonuses*

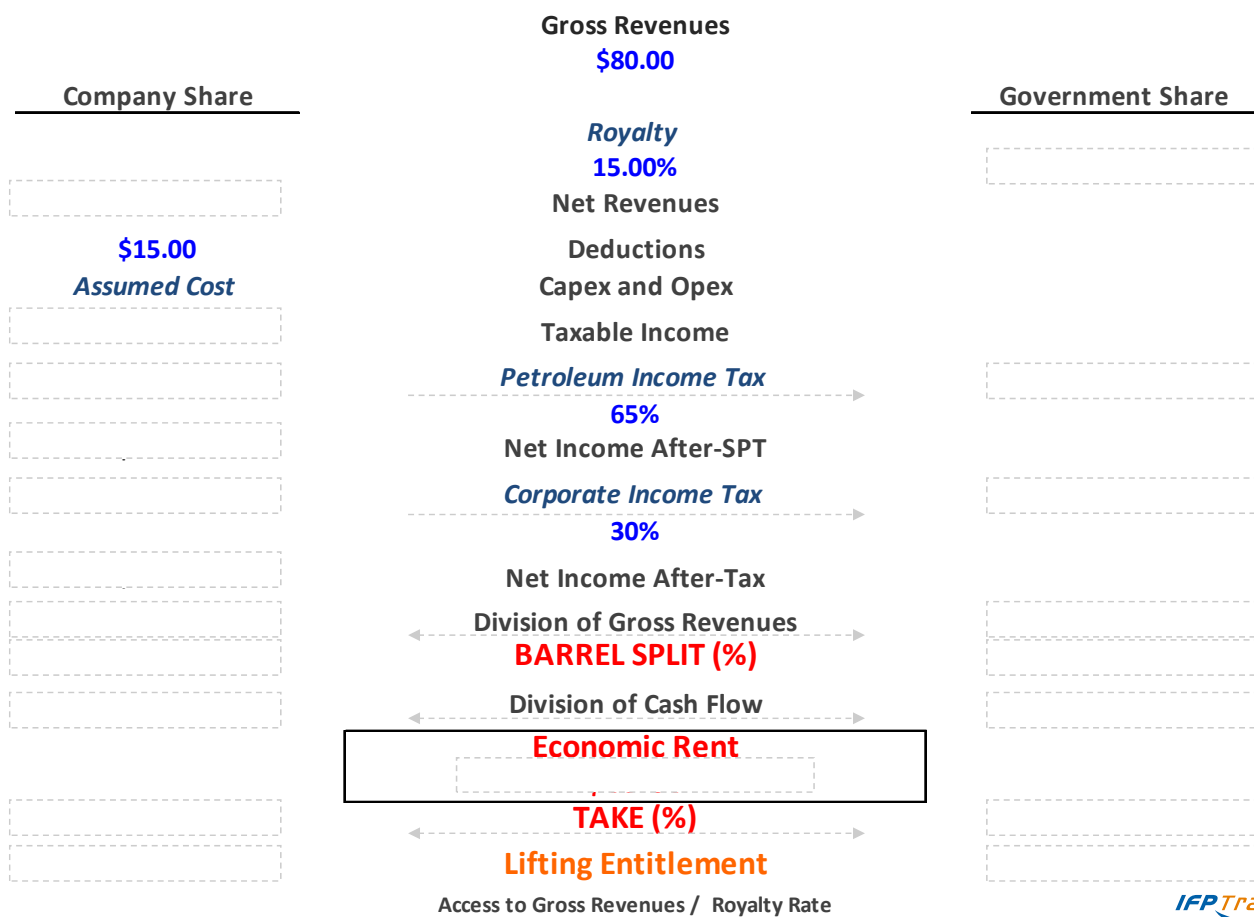
Company's Net Cash Flows = Gross Revenues – Royalties

- Capital Costs – Operating Costs – Taxes – Bonuses

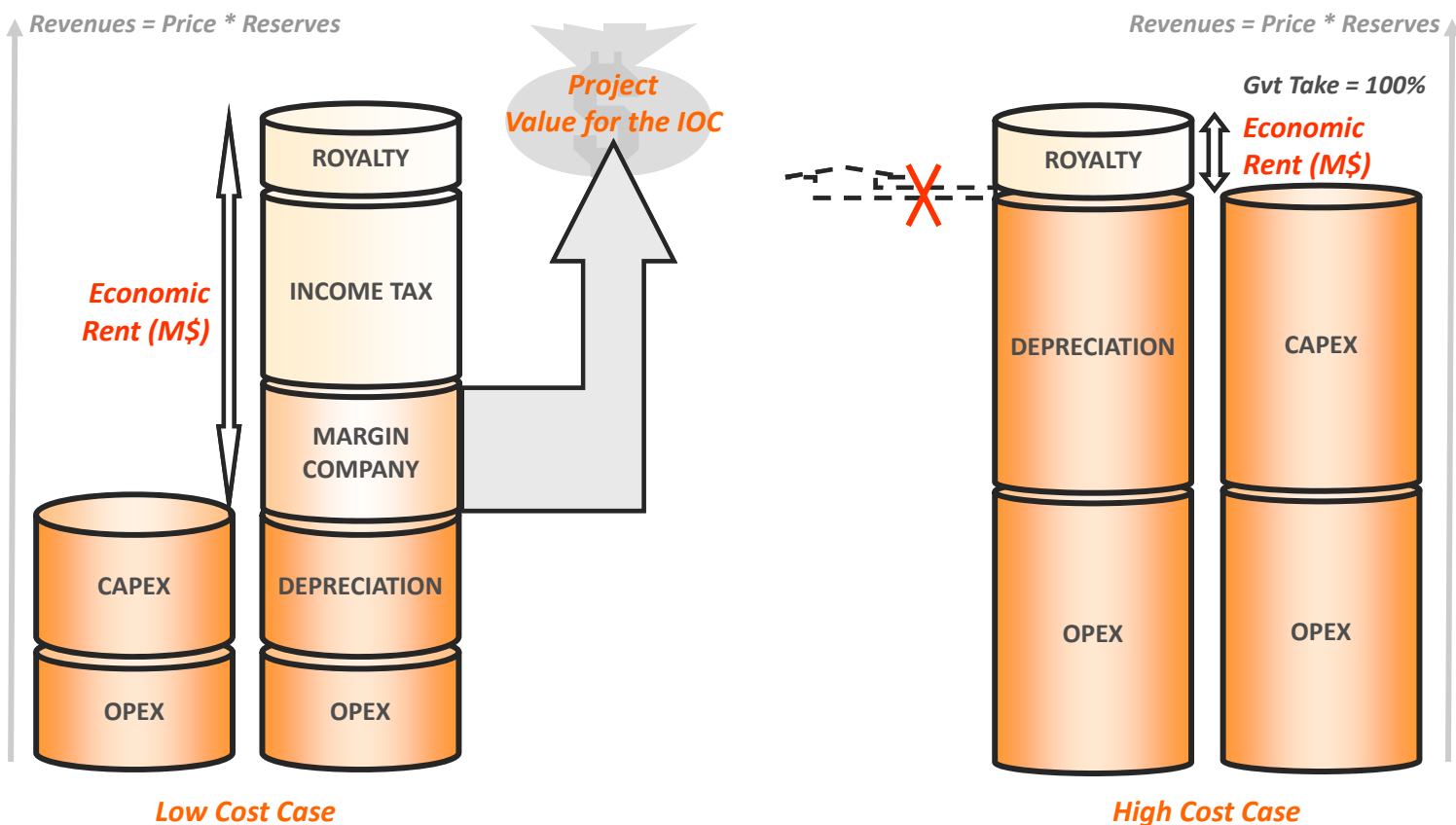


Sharing the value in a concession contract

Full Cycle Analysis

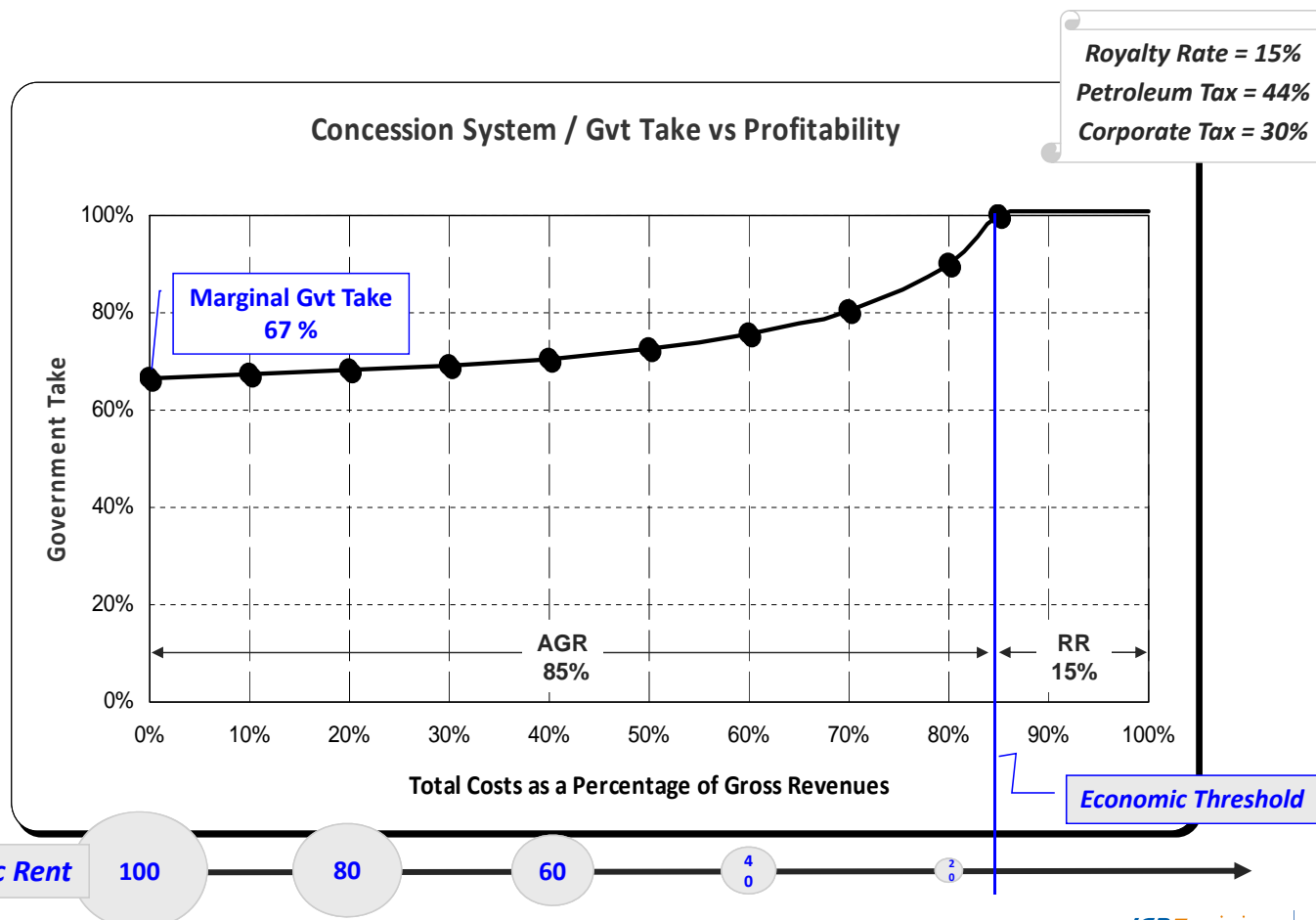


Sharing the value in a concession contract



The threshold size for a discovery to be commercial is set by the Royalty Rate

Regressive aspect of the concession system



Production Sharing / fiscal system structure

Gross Revenues = Total Oil and Gas Revenues

Royalties = Gross Revenues * Royalty Rate (%)

Cost Oil = Operating Costs + Depreciation Charges + *Investment Credits or Uplift*
+ *Intangible Capital Costs* + *Financial Charges*
+ *Unrecovered Costs Carried Forward* + *Abandonment Cost Provisions*

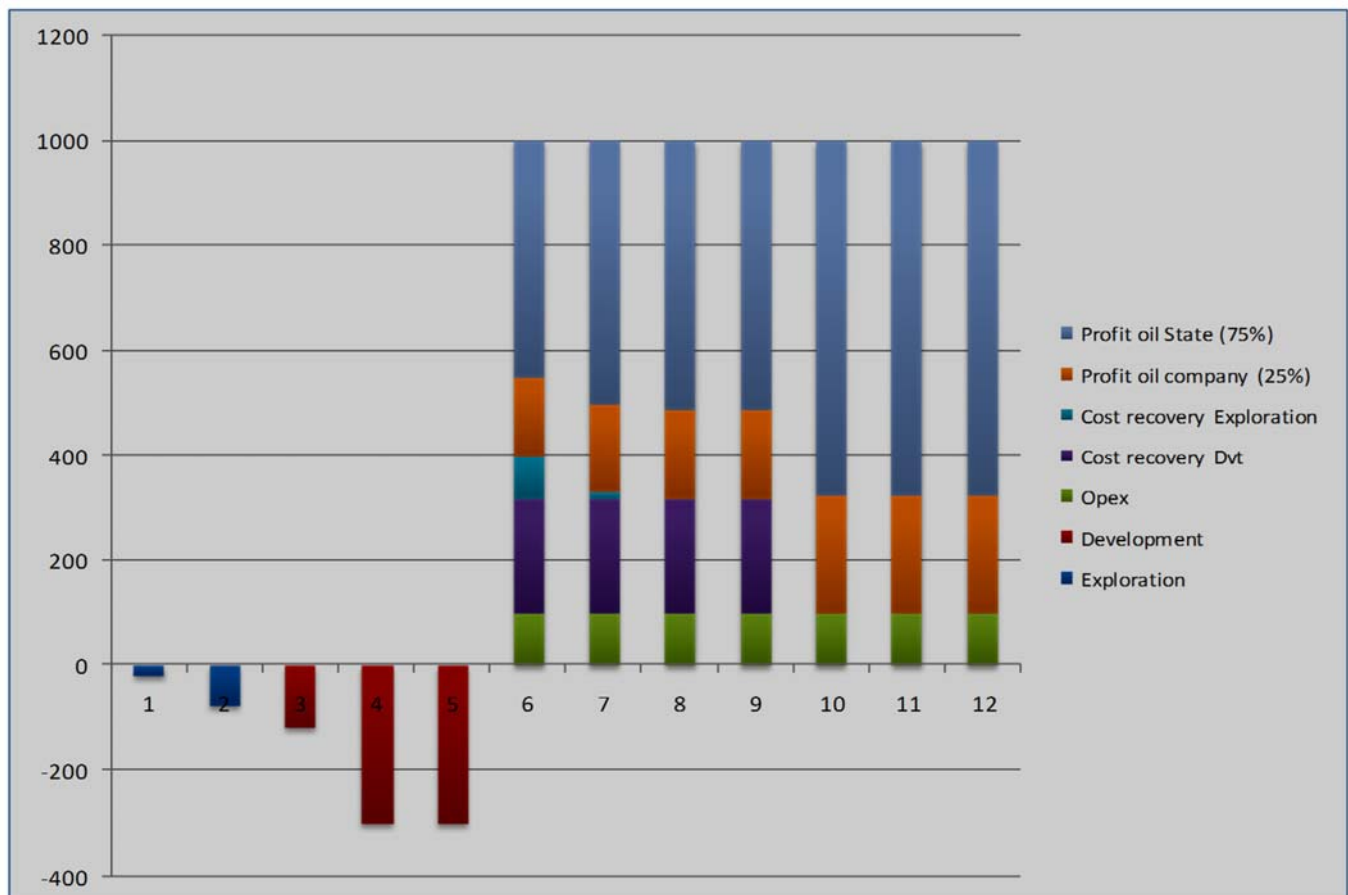
Profit Oil = Gross Revenues – Royalties – Cost Oil

Contractor Profit Oil = Profit Oil * Contractor Share (%)

Taxable Income = Gross Revenues – Royalties – Government Profit Oil
– Operating Costs – Depreciation Charges – *Intangible Capital Costs*
– *Financial Charges* – *Tax Loss Carry Forward*
– *Abandonment Cost Provisions* – *Bonuses*

Company's Net Cash Flows = Gross Revenues – Royalties – Capital Costs
– Operating Costs – Government Profit Oil – Taxes – Bonuses

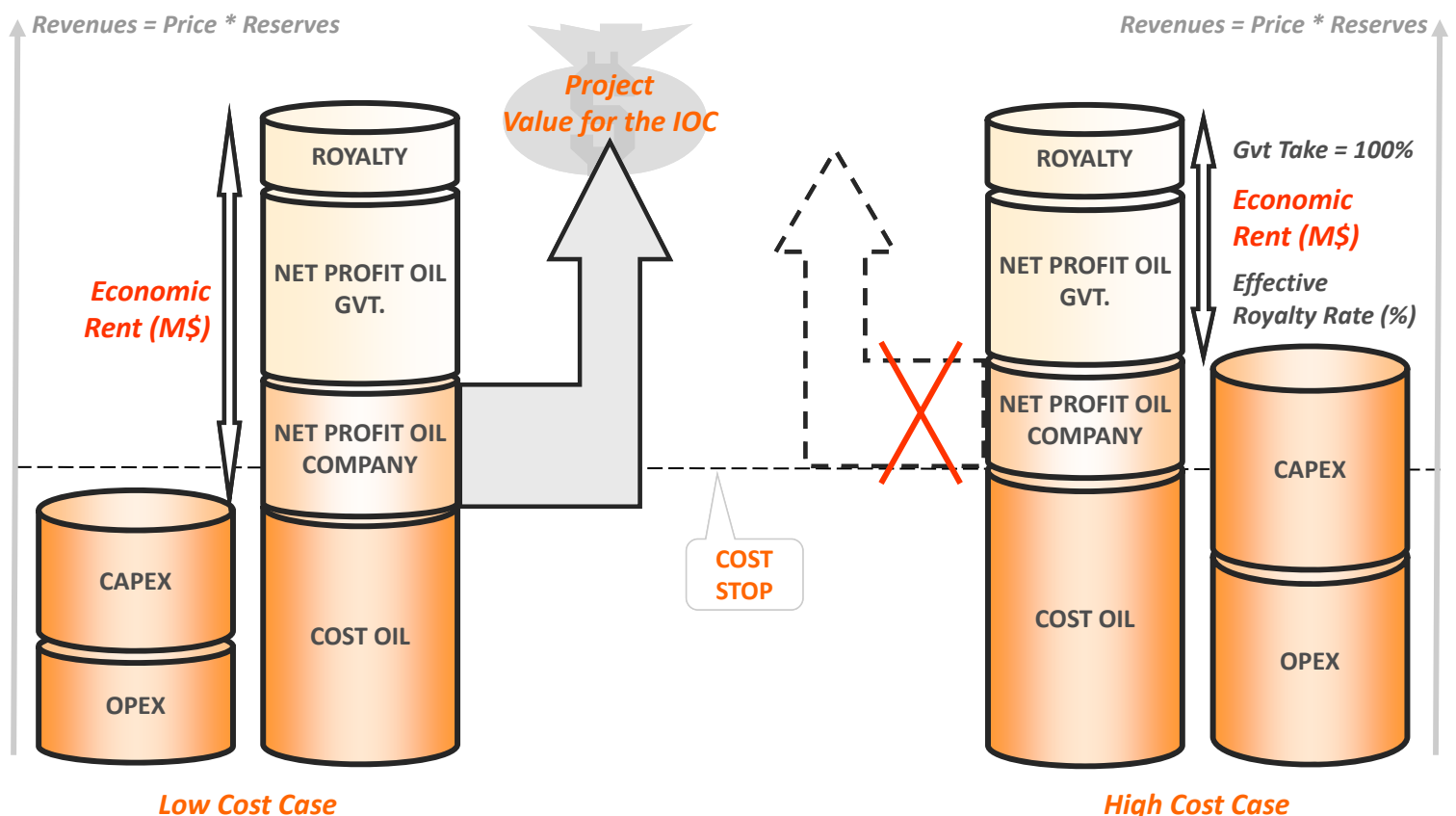
Production sharing system dynamics



Full Cycle Analysis

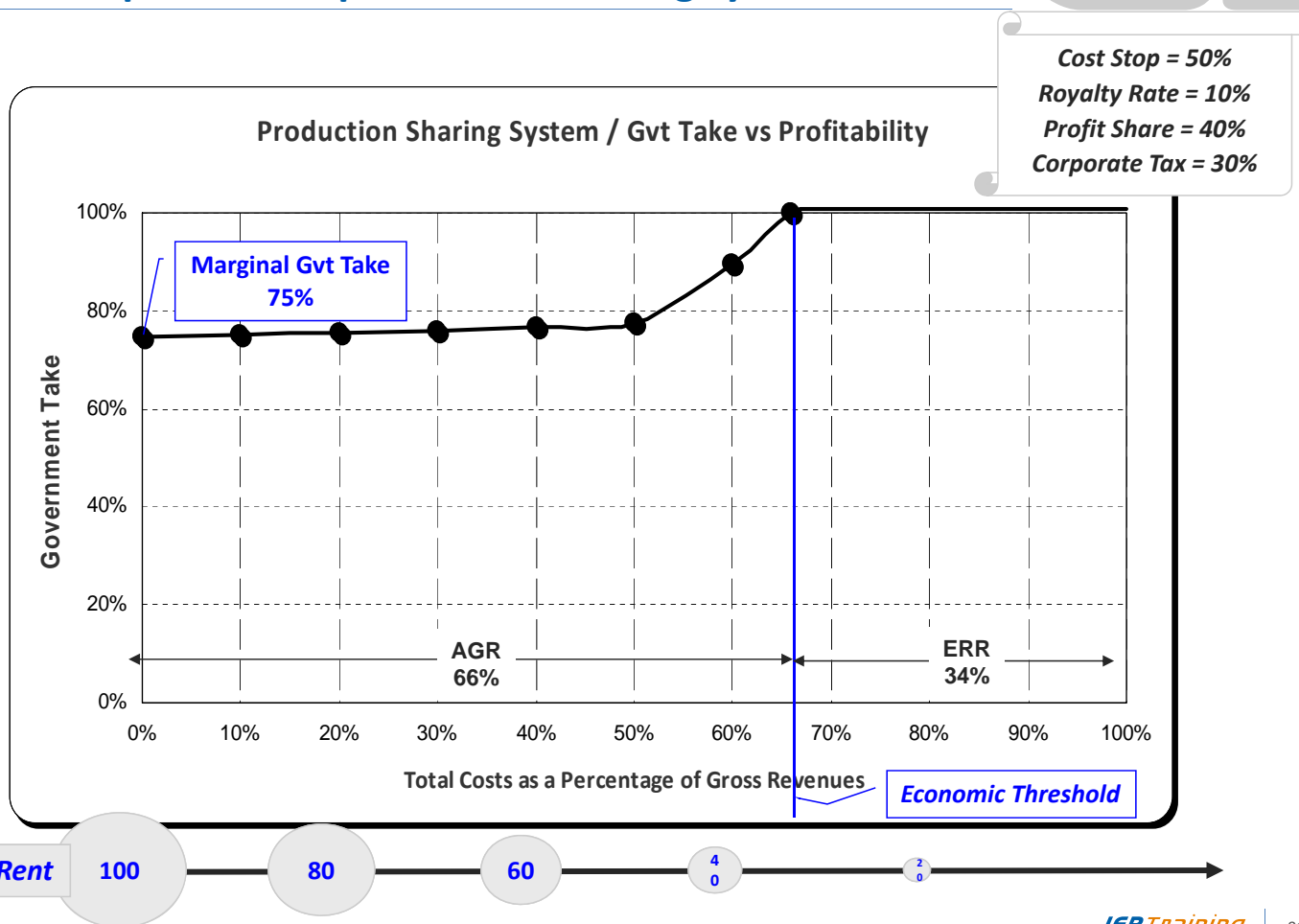


Saturation of a production sharing contract



The threshold size for a discovery to be commercial is set by the Effective Royalty Rate

Regressive aspect of the production sharing system



Risk-service contract with a maximum fee

- **Service Fee = Petroleum Costs + Remuneration**
- **Remuneration = Remuneration Fee * Production * R Factor * Performance Factor**
- **Maximum Service Fee = 50% Value of Production**

Revenues / Expenses	R Factor
$R/E < 1$	100%
$1 < R/E < 1.25$	80%
$1.25 < R/E < 1.5$	60%
$1.5 < R/E < 2$	40%
$2 < R/E$	20%

Performance Factor = Production Achieved / Production Plateau Target

Production of Year N = 5 MMb

Oil Price = \$70/b

Value of Production = 350 M\$

Remuneration Fee = \$2.0/b

R Factor = 100%

Performance Factor = 90%

Petroleum Costs = 220 M\$

Remuneration = \$2.0 x 5 MMb x 100% x 90% = 9 M\$

Service Fee = 229 M\$

Maximum Service Fee = 50% x 350 M\$ = 175 M\$

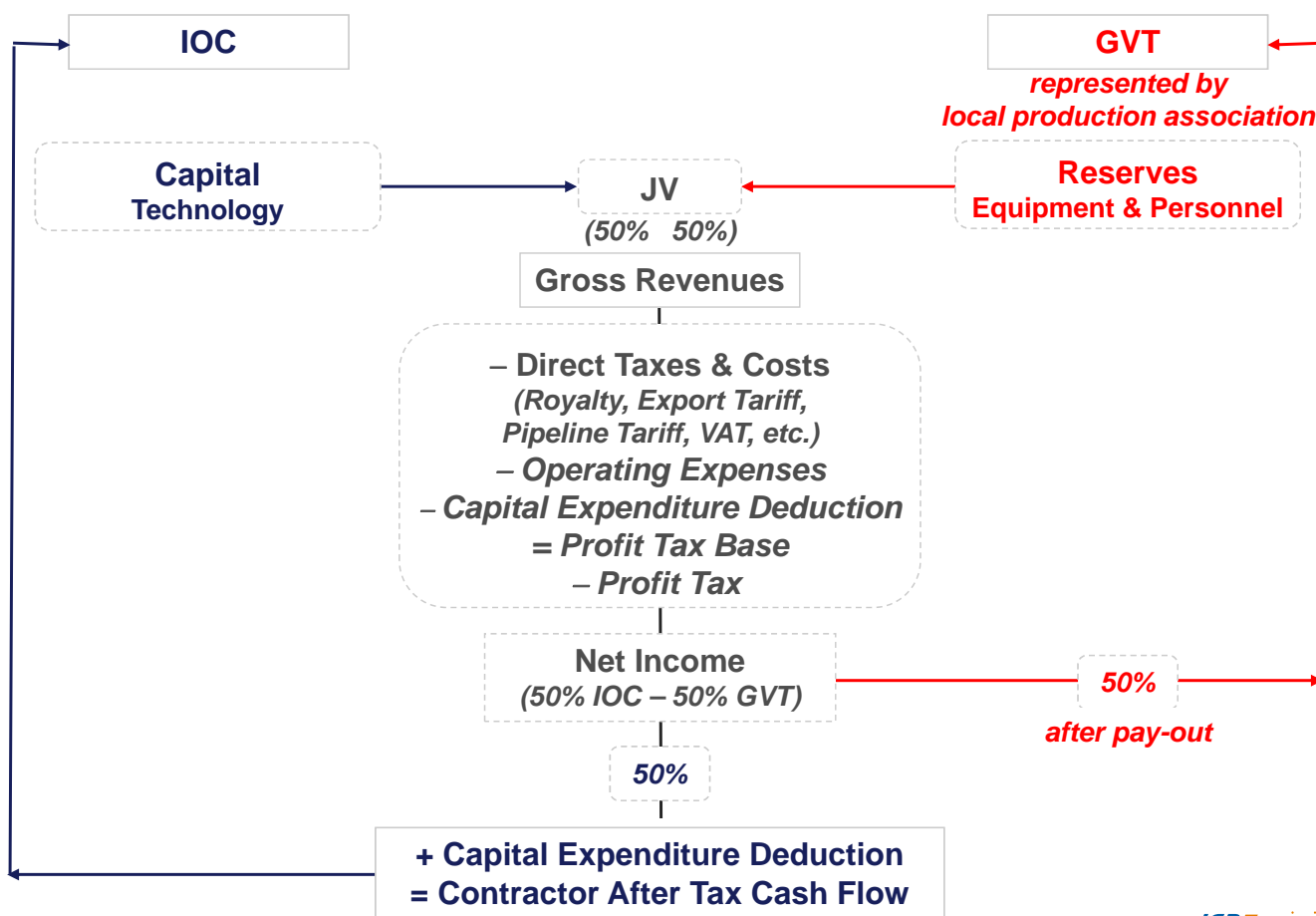
Actual Service Fee Paid = \$175 M\$

Carry Forward = 54 M\$ (Unrecovered Capex)

❑ Incorporated Joint Company

- State participation in the **capital** of an **operating company**, which can operate as early as the exploration period.
- the State, **shareholder** who can have **preferential rights**, has representatives at the Board of directors and the general meetings.
- the company is directly **subject** to the **applicable taxation** (not each shareholder separately), since the company is a legal entity.

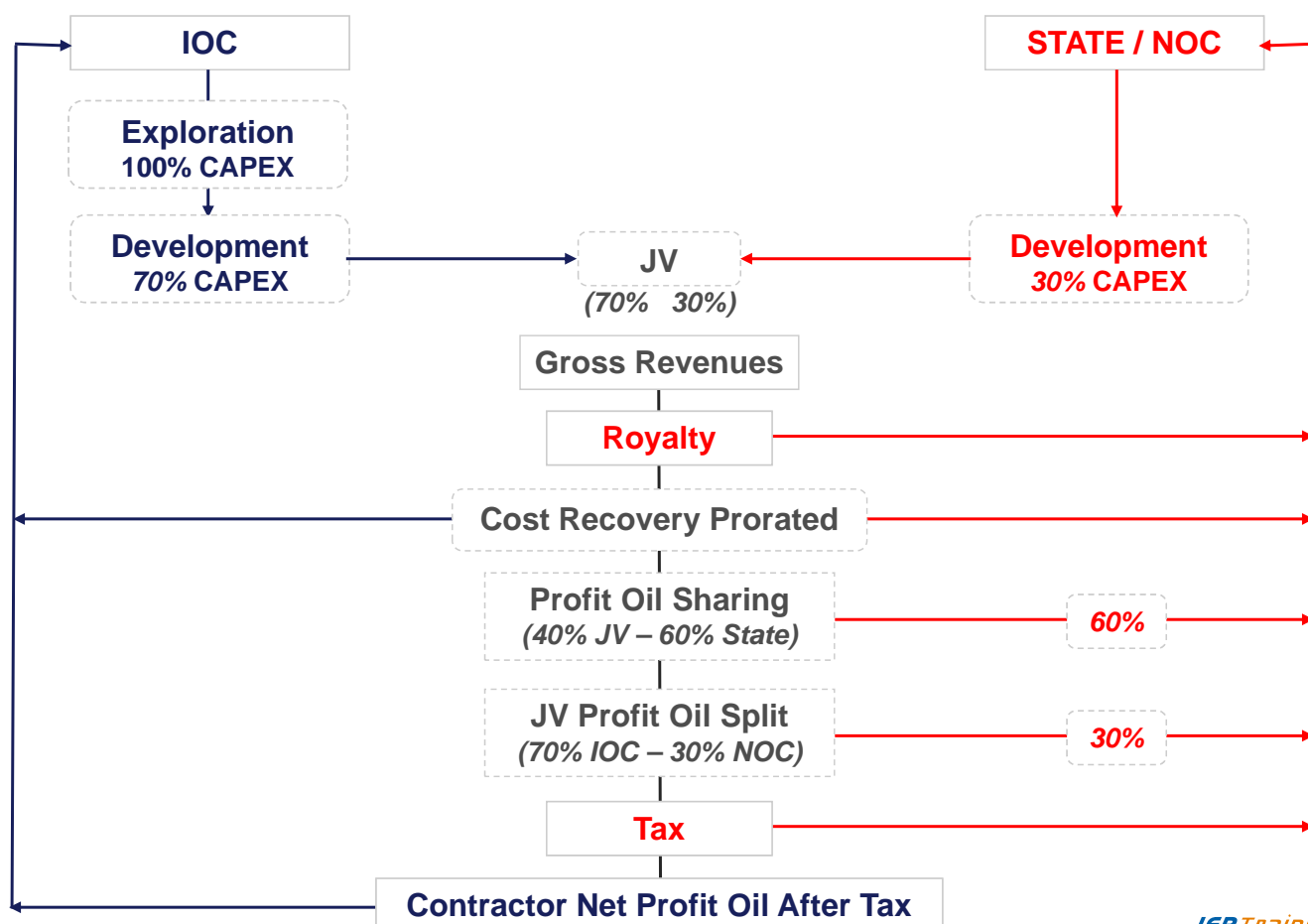
State participation / Incorporated Joint Company



❑ Association or Unincorporated Joint Venture

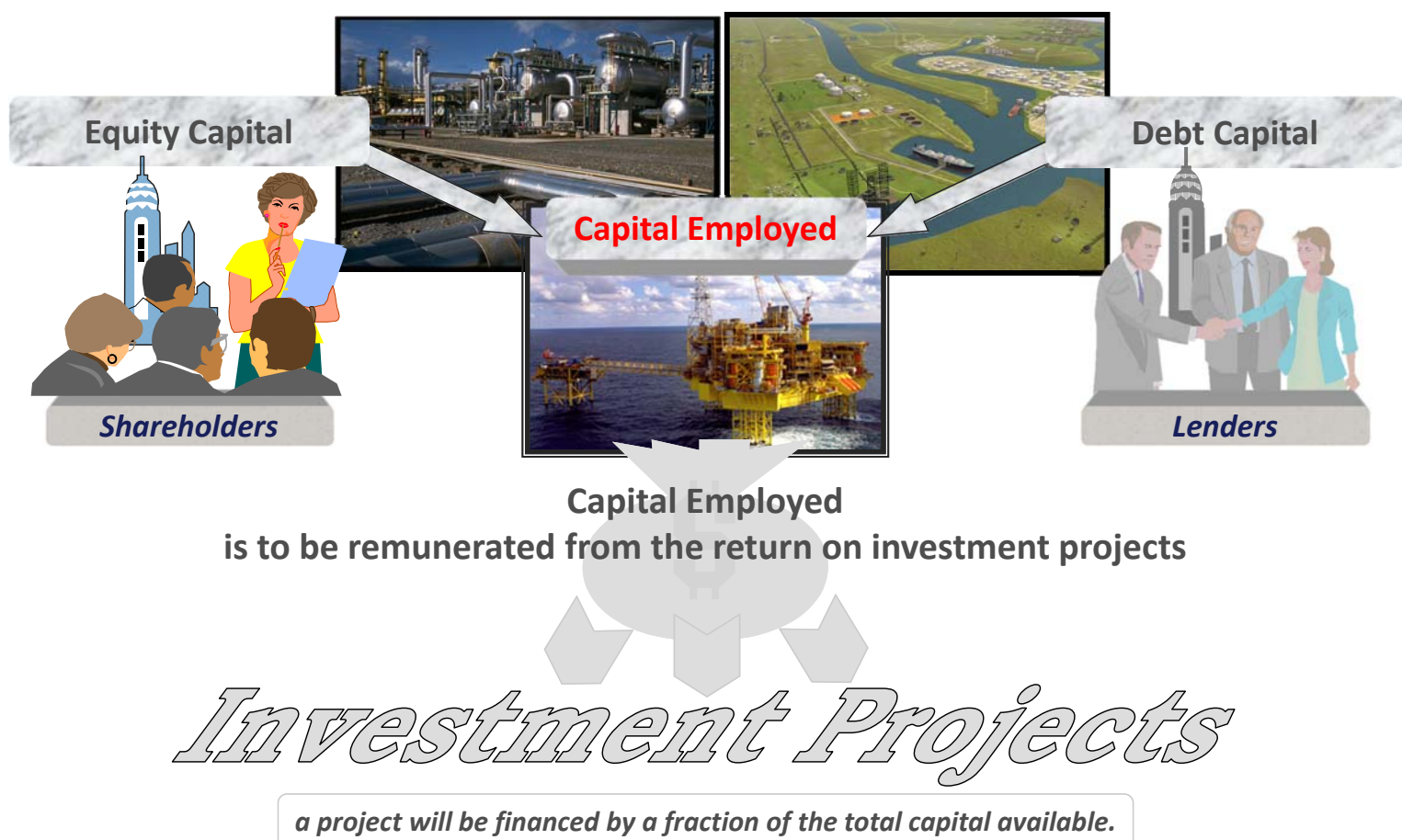
- **participation**, after a commercial discovery is made, with a minority or majority **participating interest**.
- partners **do not create a company** as a legal entity but an association or unincorporated joint venture.
- Partners rights and obligations governed by an **Association Agreement** (Joint Operating Agreement or **JOA**).

State participation / Unincorporated Joint Venture



Field Development Project Economic Evaluation

Central question: remuneration of capital employed



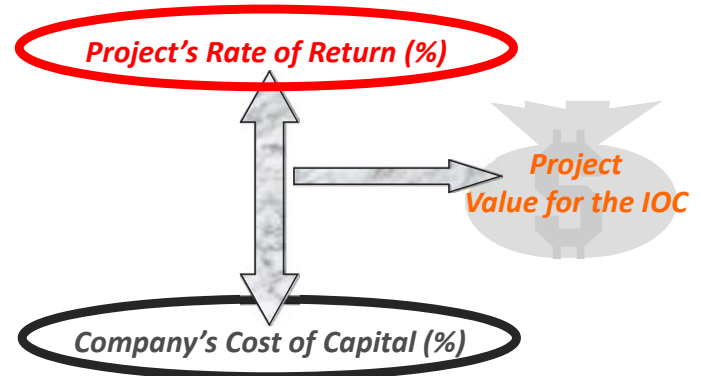
All funds make up total capital employed to which one must associate a single cost

WEIGHTED AVERAGE COST OF CAPITAL

Investment projects must provide
an economic profitability

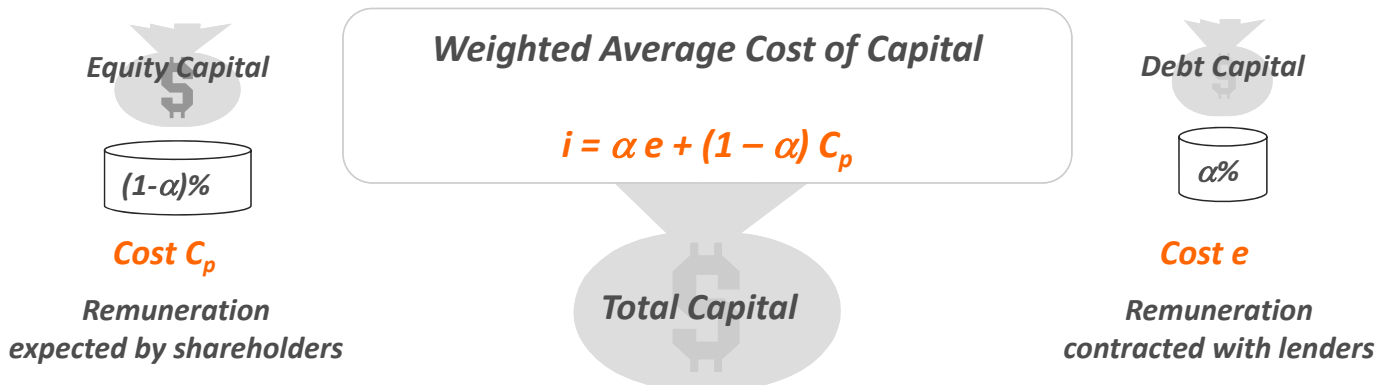
higher than

the company's average cost of capital



Corporate finance and weighted average cost of capital

α Company's Debt Ratio (Debt Capital / Total Capital)



Example

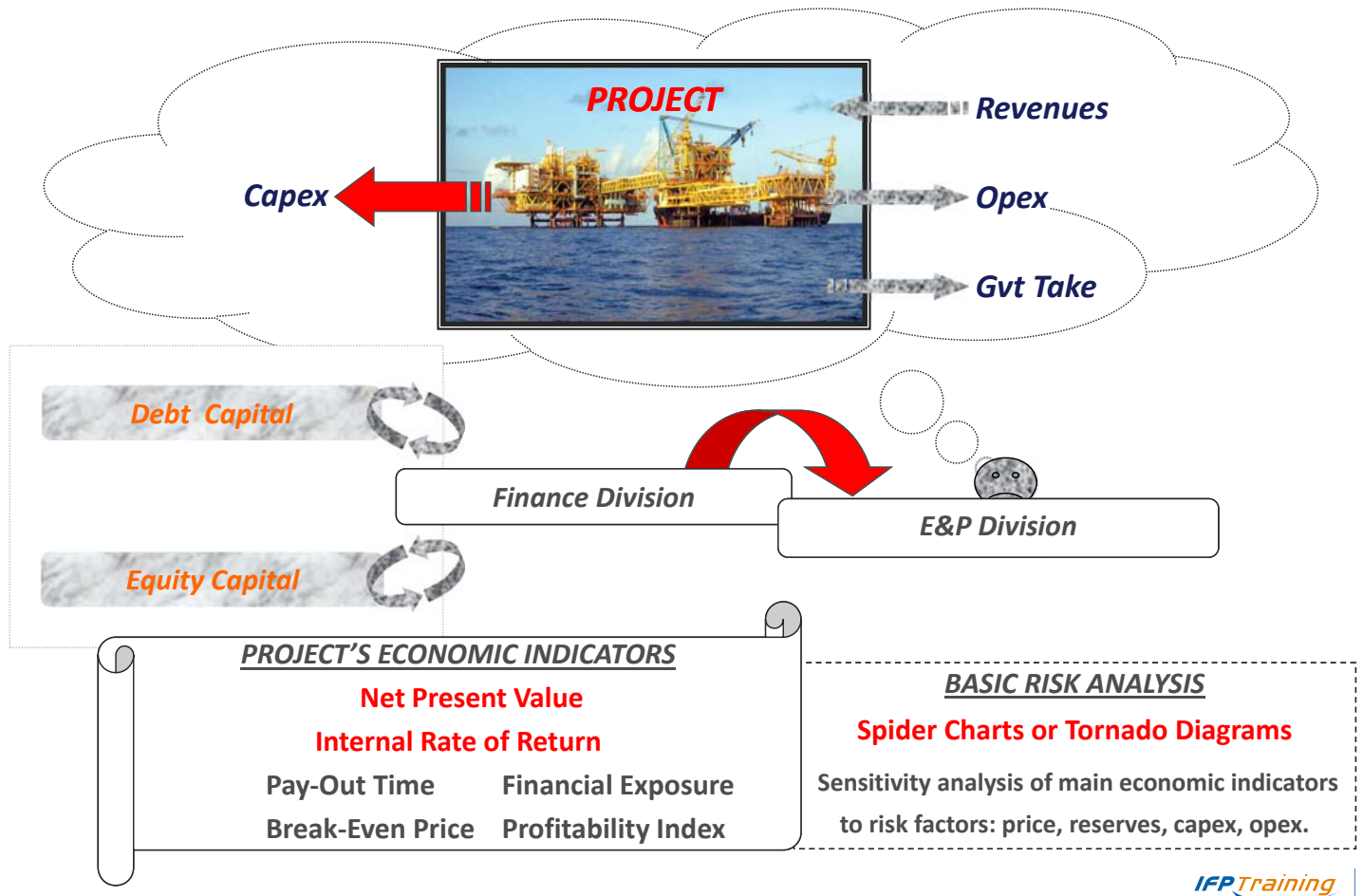
$\alpha = 25\%$ Debt

$1 - \alpha = 75\%$ Equity

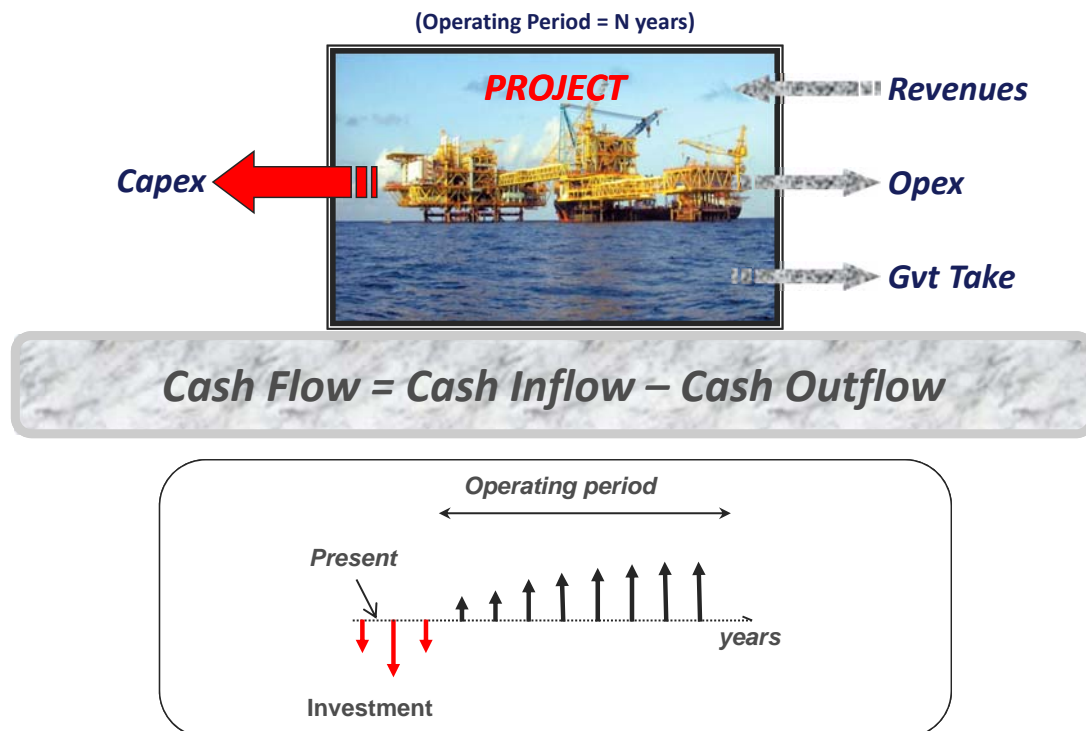
cost $e = 4\%$

cost $C_p = 12\%$

$$WACC = i = 0.25 \cdot 4\% + 0.75 \cdot 12\% = 10\%$$



Need to discount an investment project's cash flows



It is not valid to compare funds received or spent at different periods.

One must “bring” all cash flows from the future to the present,
that is
discount all the project's cash flows.

Time value of money and discount rate

Future Value in year n of a Present Cash Flow CF_0

$$CF_0 \xrightarrow[\text{compounding}]{i} CF_n = CF_0 \cdot (1+i)^n$$

Amount that can be obtained in year n from saving every year, with an annual interest i , the present cash flow CF_0

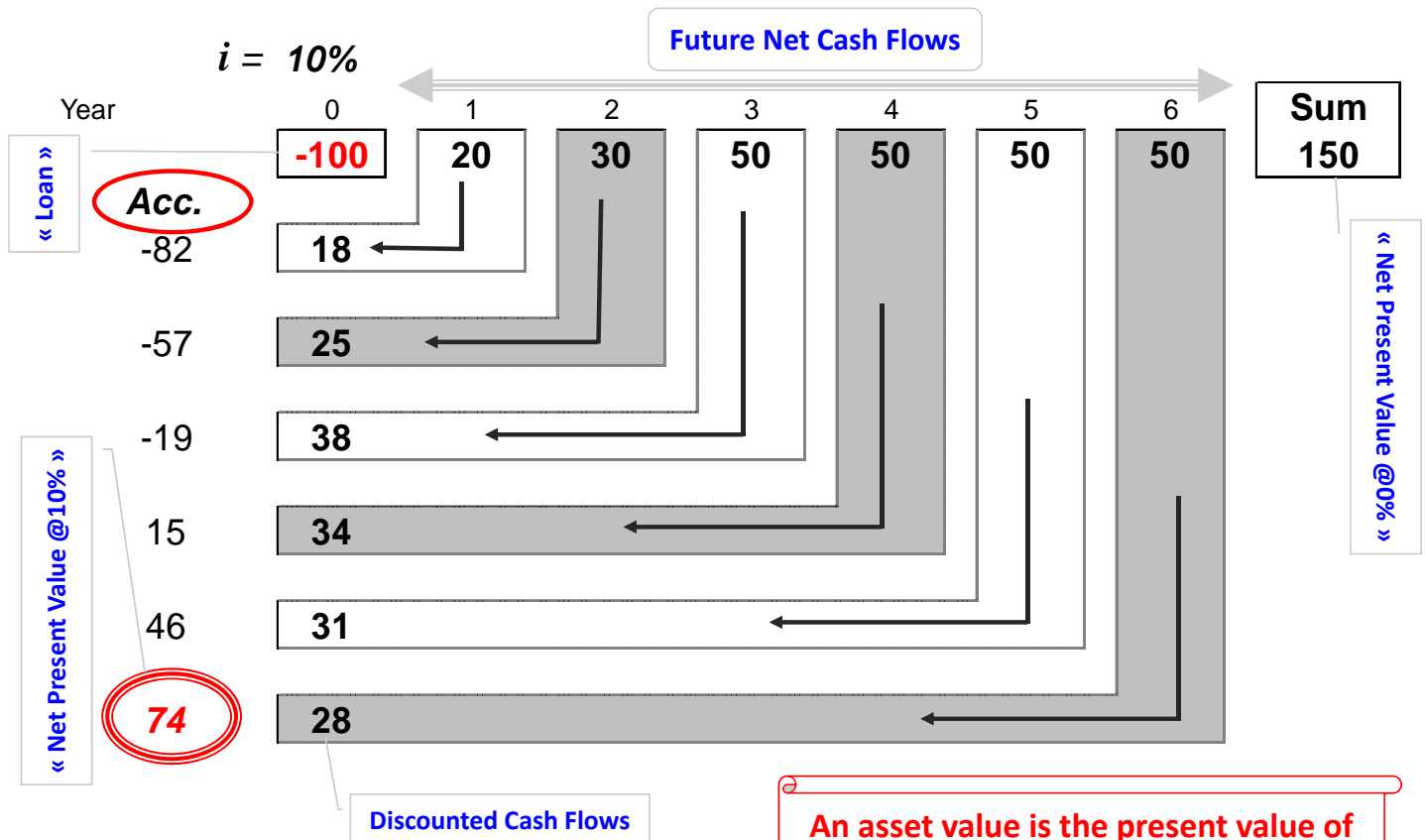
Present Value of a Future Cash Flow CF_n from year n

$$CF_0 = \frac{CF_n}{(1+i)^n} \leftarrow \text{discounting}$$

Amount that can be borrowed today and paid back,
with an annual interest i , in n years with the future cash flow CF_n

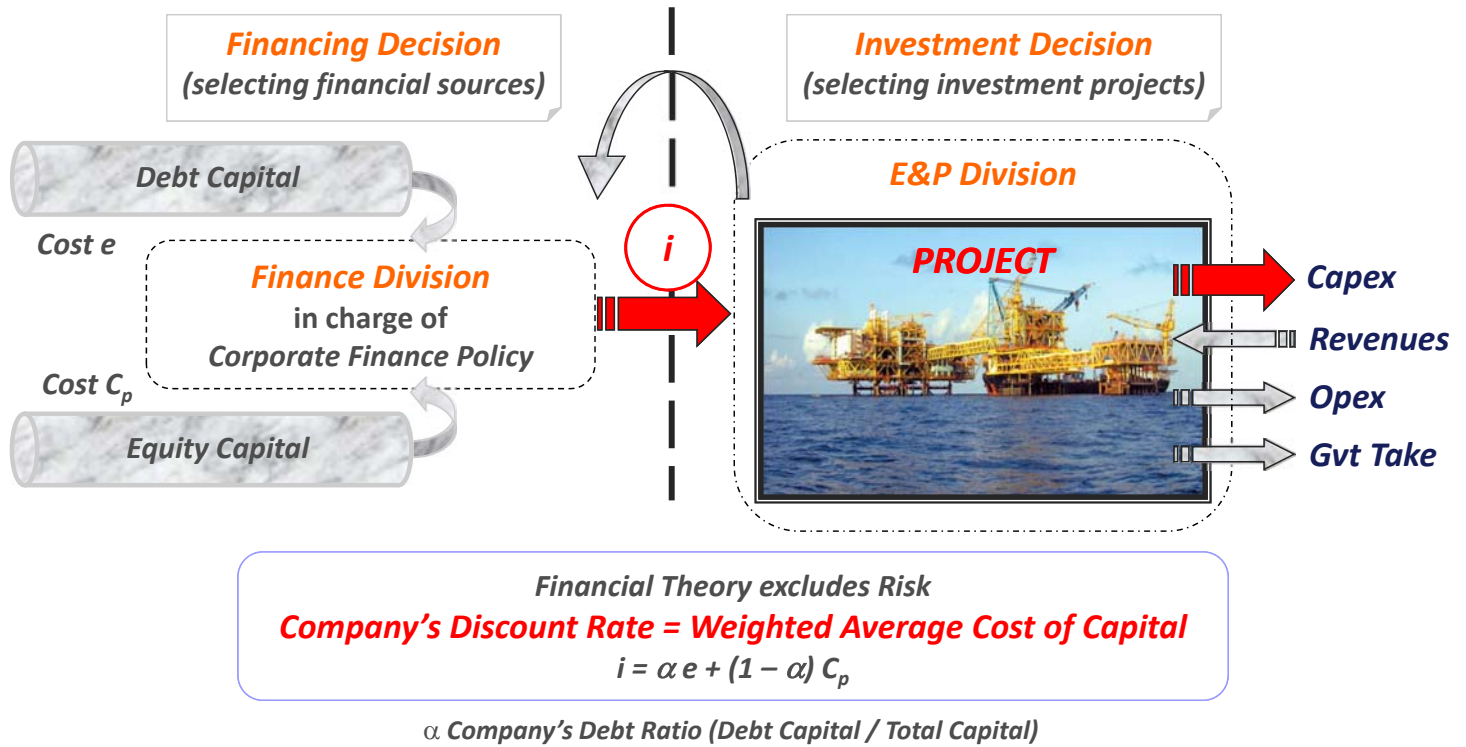
***In the absence of risk, Time Value of Money is measured by
Discount Rate = Cost of Capital***

Concept of net present value



An asset value is the present value of its future net cash flows

Corporate finance and discount rate of a company



For the management of the company facing technical, economic, and contractual risks,

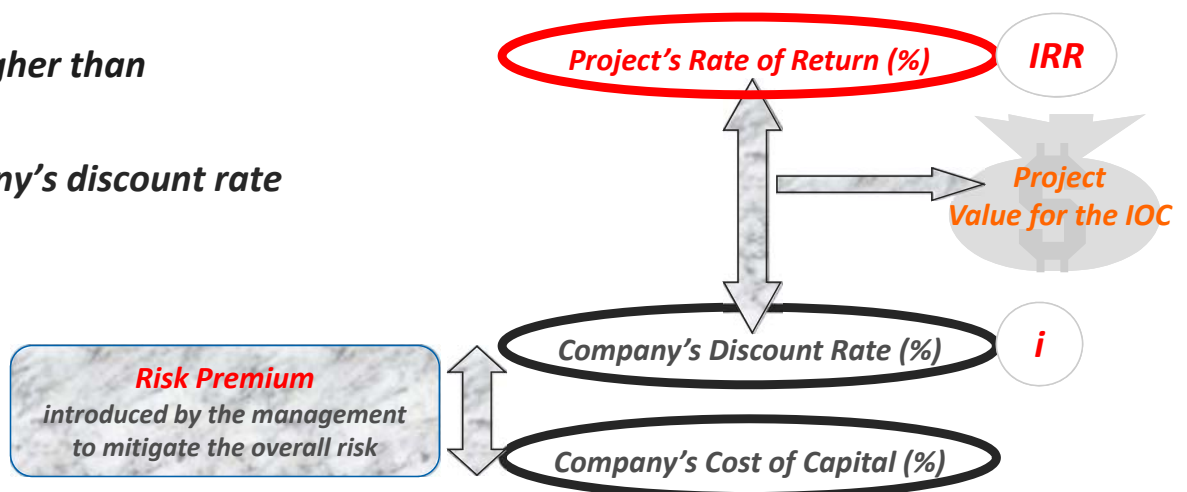
Company's Discount Rate = Weighted Average Cost of Capital + Risk Premium

Fundamental condition for value creation

Investment projects must provide
an economic profitability

higher than

the company's discount rate



A company present in several sectors and/or several countries with **different levels of risk** must then use **several discount rates** incorporating its **own perception of risk**.

Condition 1

The size of the project does not change significantly the financial structure of the firm.

- ❑ The relative weight of the firm's various sources of financing should not be modified.
- ❑ If that is not the case, the average cost of capital is determined from the new financial structure which incorporates the financing of the project.

Condition 2

There is no capital rationing.

- ❑ At the limit of the budget constraint, each selected project limits further access to loans.
- ❑ This would then change the average cost of capital.

Economic criteria / Net Present Value

(Operating Period = N years)

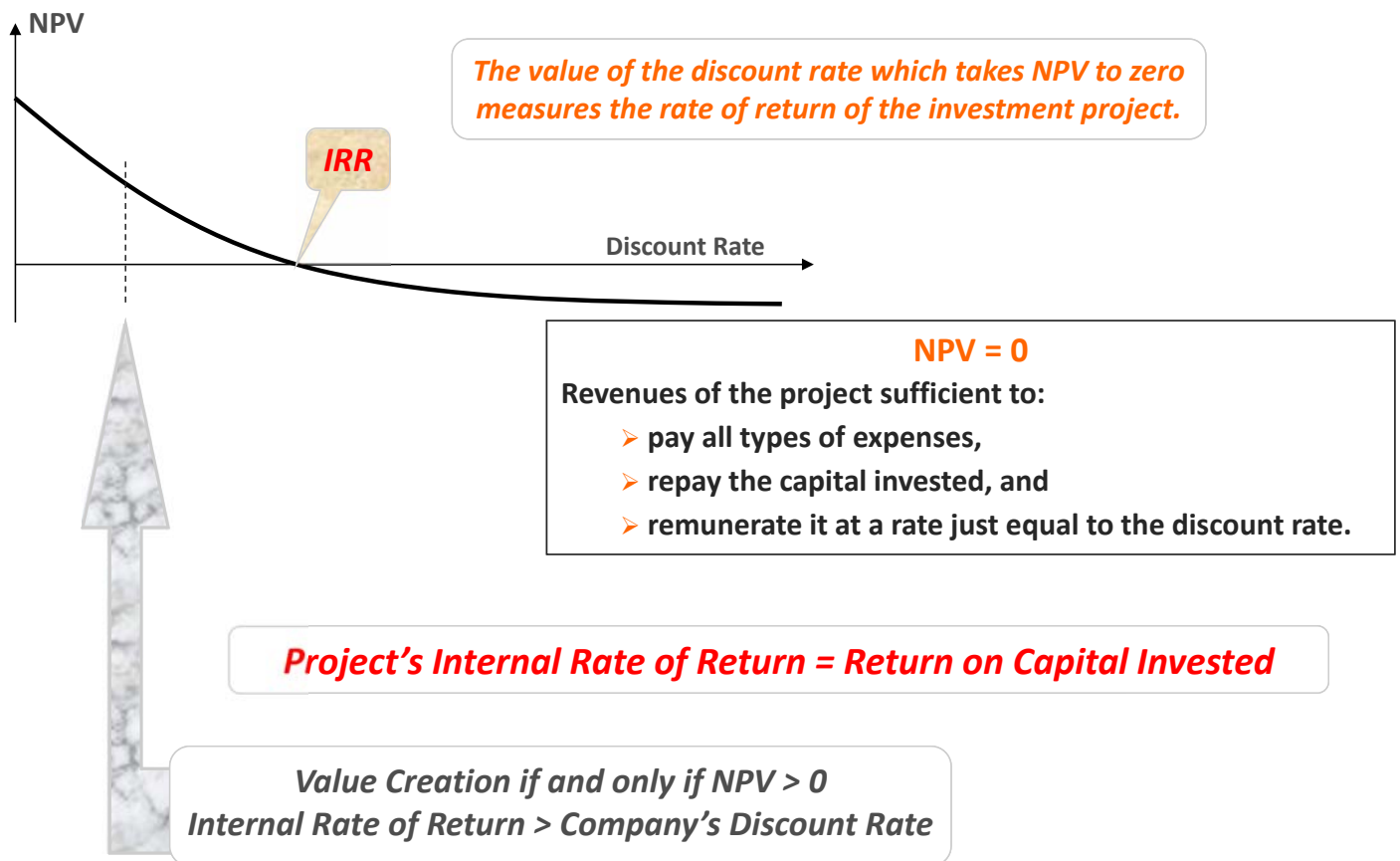
Cash Flows Schedule

Year		0 .. to ... N
Revenues		(1)
Capex		(2)
Opex		(3)
Gvt Take		(4)
Company's Cash Flows		$CF = (1-2-3-4)$

$$NPV = \sum_{n=0}^N \frac{CF_n}{(1+i)^n}$$

Year	0	1	...	C	...	N
Discounting at a rate i	1	(1+i)	...	(1+i) ⁿ	...	(1+i) ^N
Cash Flows	CF ₀	CF ₁	...	CF _n	...	CF _N
Discounted Cash Flows	CF ₀	CF ₁ /(1+i)	...	CF _n /(1+i) ⁿ	...	CF _N /(1+i) ^N
Net Present Value = Sum of Discounted Cash Flows						

Economic criteria / Internal Rate of Return

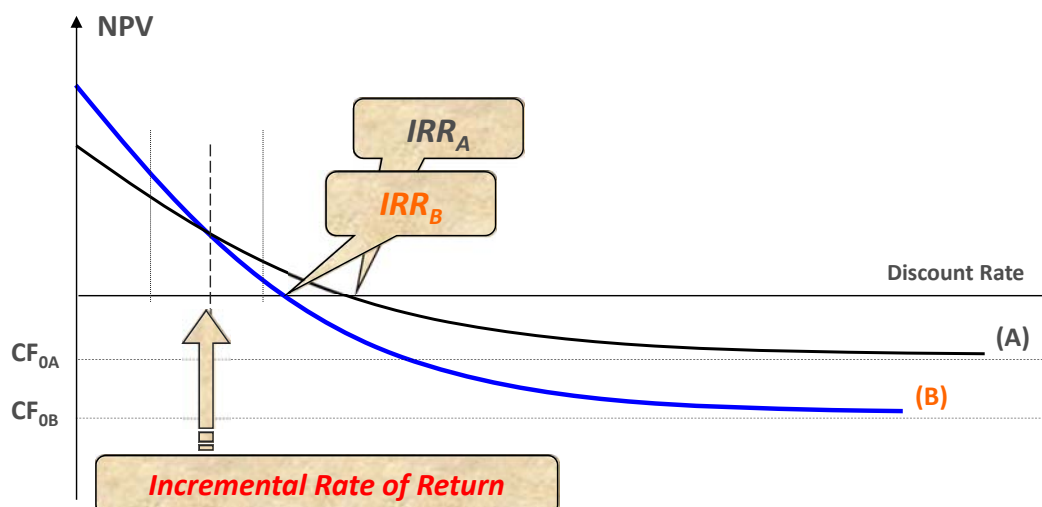


Economic criteria / Incremental Rate of Return

To compare two mutually exclusive projects

coherently with the principle of maximizing value creation,

one needs to analyze **the return on the differential investment.**



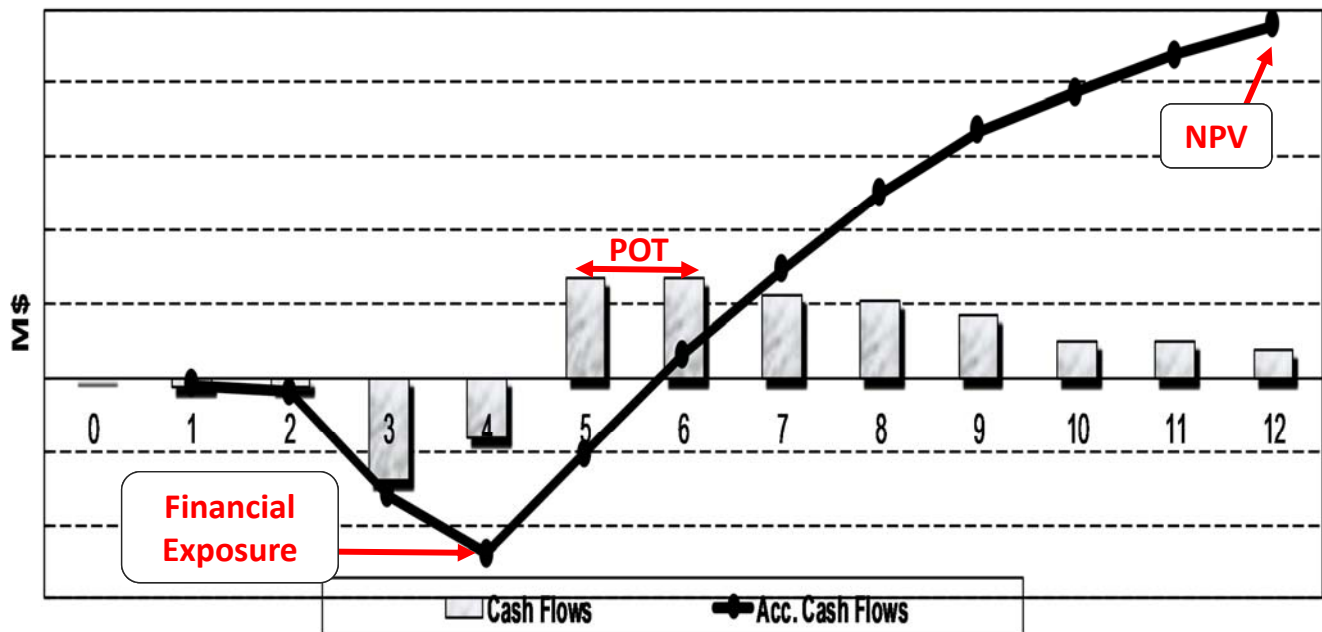
Differential Project (B/A) is described by the Differential Cash Flows

Incremental rate of return = Discount rate for which $NPV(B/A) = NPV(B) - NPV(A) = 0$

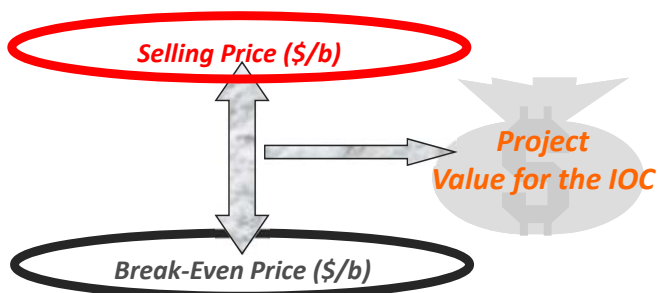
Economic criteria / Pay-Out Time - Financial Exposure

Pay-Out Time:

Operating period necessary for the cash flows from the project to reimburse the capital invested.



Economic criteria / Break-Even Price - Profitability Index



BREAK-EVEN PRICE

Selling Price such that NPV = 0

No Profit, No Loss

Break-Even Price = Unit Economic Cost

$$PI = \frac{NPV}{Investment}$$

$$PI = \frac{NPV}{Financial Exposure}$$

PROFITABILITY INDEX

A MEASURE OF VALUE CREATED PER DOLLAR INVESTED

To select between various independent investment projects with the constraint of a limited budget, there are two simple methods:

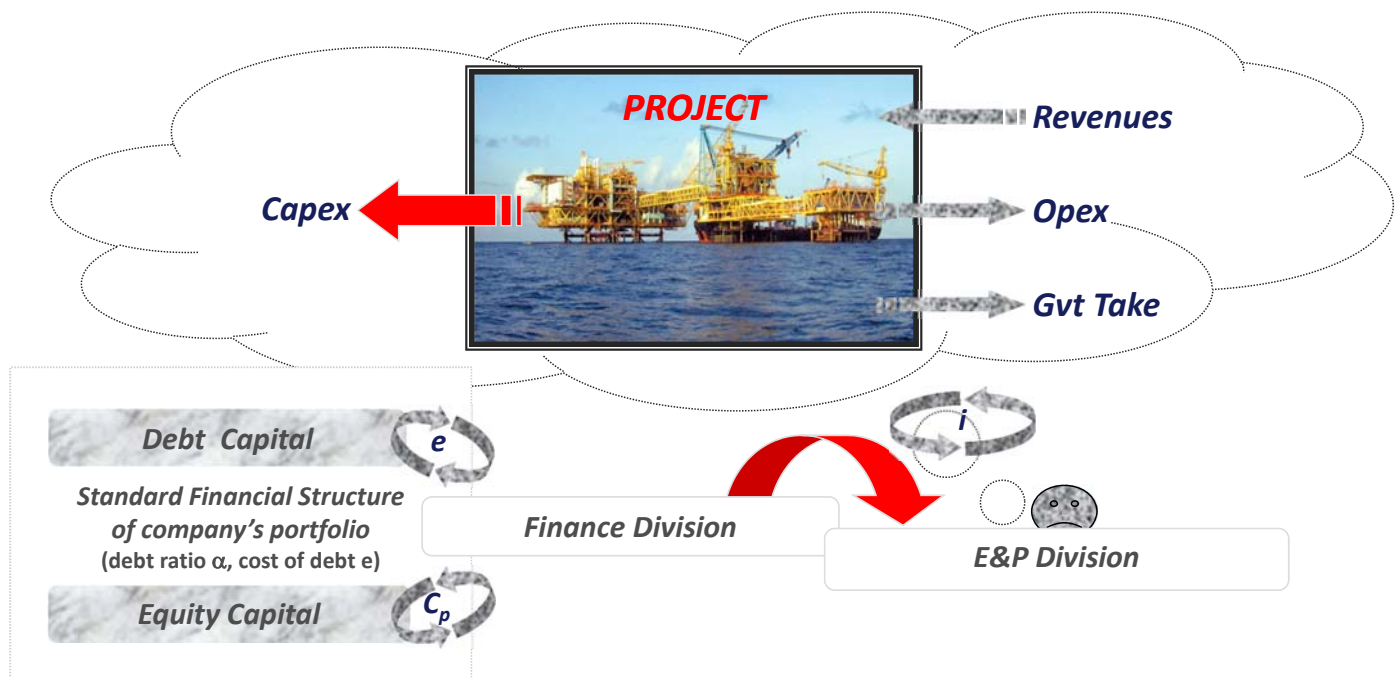
Profitability index method

Projects are ranked according to **decreasing profitability index** and picked, one after the other, up to the point where
Total CAPEX = Capital Available

Scarcity cost of capital

Projects are ranked according to **decreasing internal rate of return** and picked, one after the other, up to the point where
Total CAPEX = Capital Available

Global profitability analysis / Concept



Practical experience incorporates management's assessment of risk
Discount Rate = i = Weighted Average Cost of Capital + Risk Premium

Monetary depreciation in cash flow analysis

Money of the Day with an Inflation Rate d



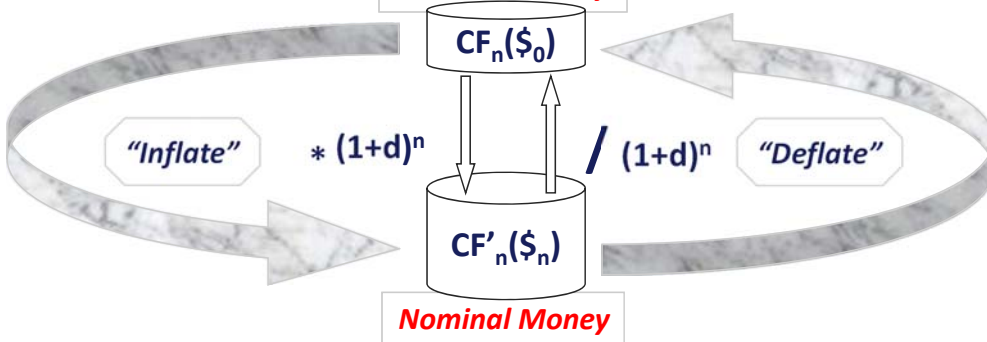
$$1\$_0 = 1\$_n * (1+d)^n$$

$$1\$_n = 1\$_0 / (1+d)^n$$

Monetary depreciation is summarized in the annual inflation rate measured by the Consumer Price Index

Cash Flow of Year n

Constant Money



Escalation Rates in nominal money and constant money

$$1+\delta' = (1+\delta) * (1+d)$$

$$\delta' \approx \delta + d$$

Constant in Constant Money
 $\delta = 0$ and thus $\delta' = d$

Interest rates in nominal money and constant money

Without Inflation



Lenders



S_0
Loan

$$S_n = S_0 * (1+e)^n$$

e interest rate
(in real terms)



Lenders



S_n
Payoff

With Inflation



Lenders



S_0
Loan

$$S'_n = S_0 * (1+e')^n = S_n * (1+d)^n$$

e' interest rate
(in nominal terms)



Lenders

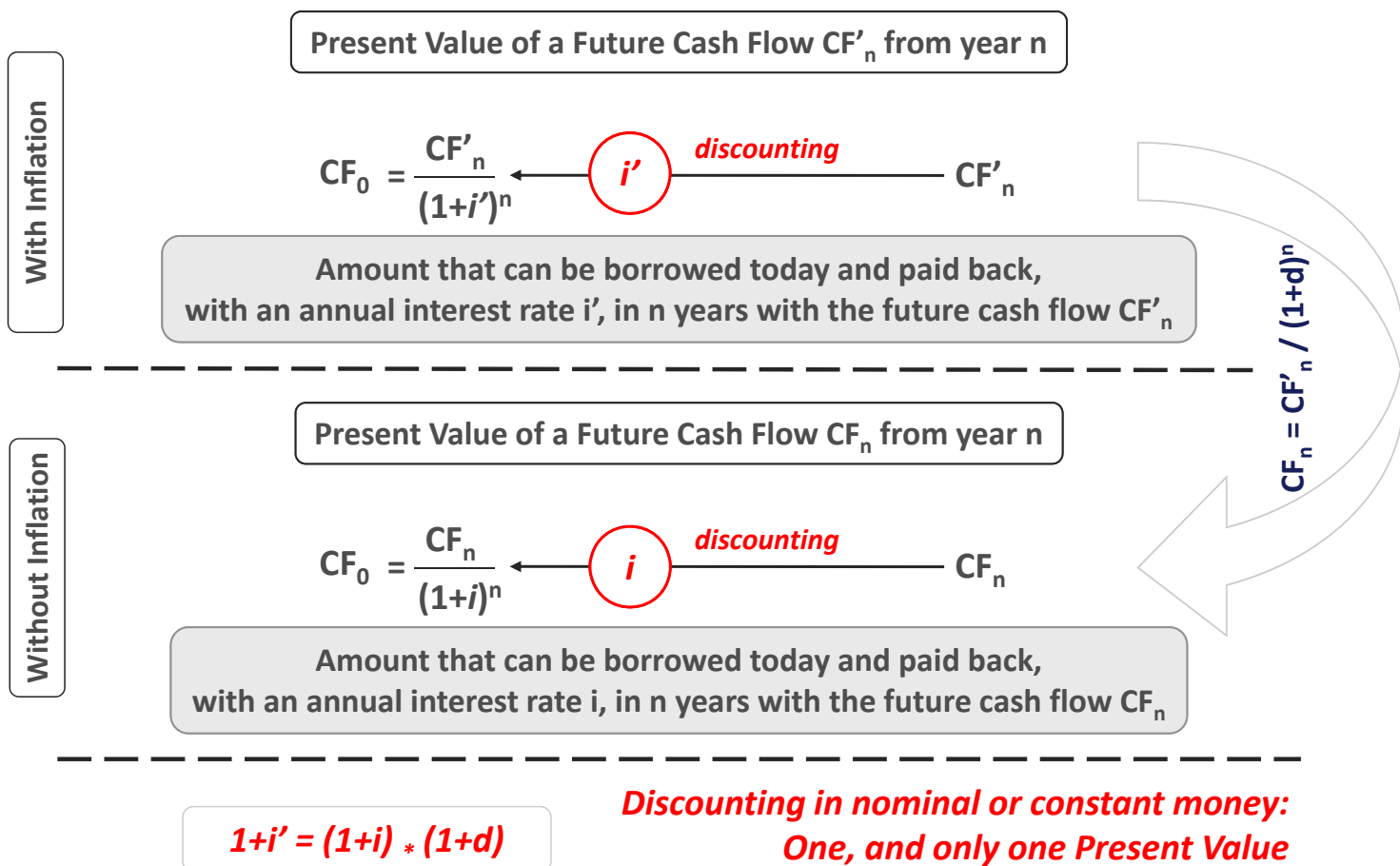


S'_n
Payoff

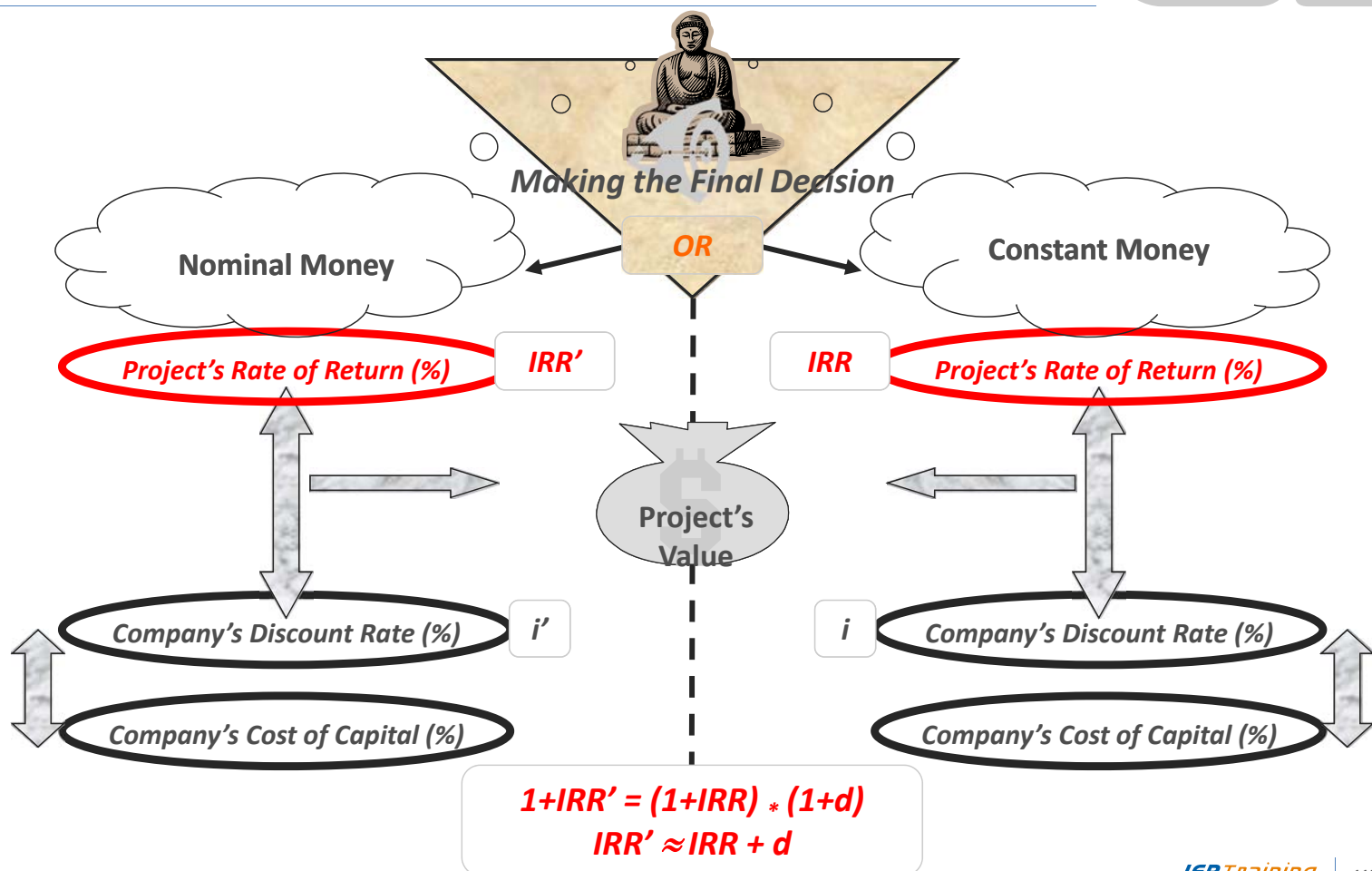
$$(1+e') = (1+e) * (1+d)$$

$$e' \approx e + d$$

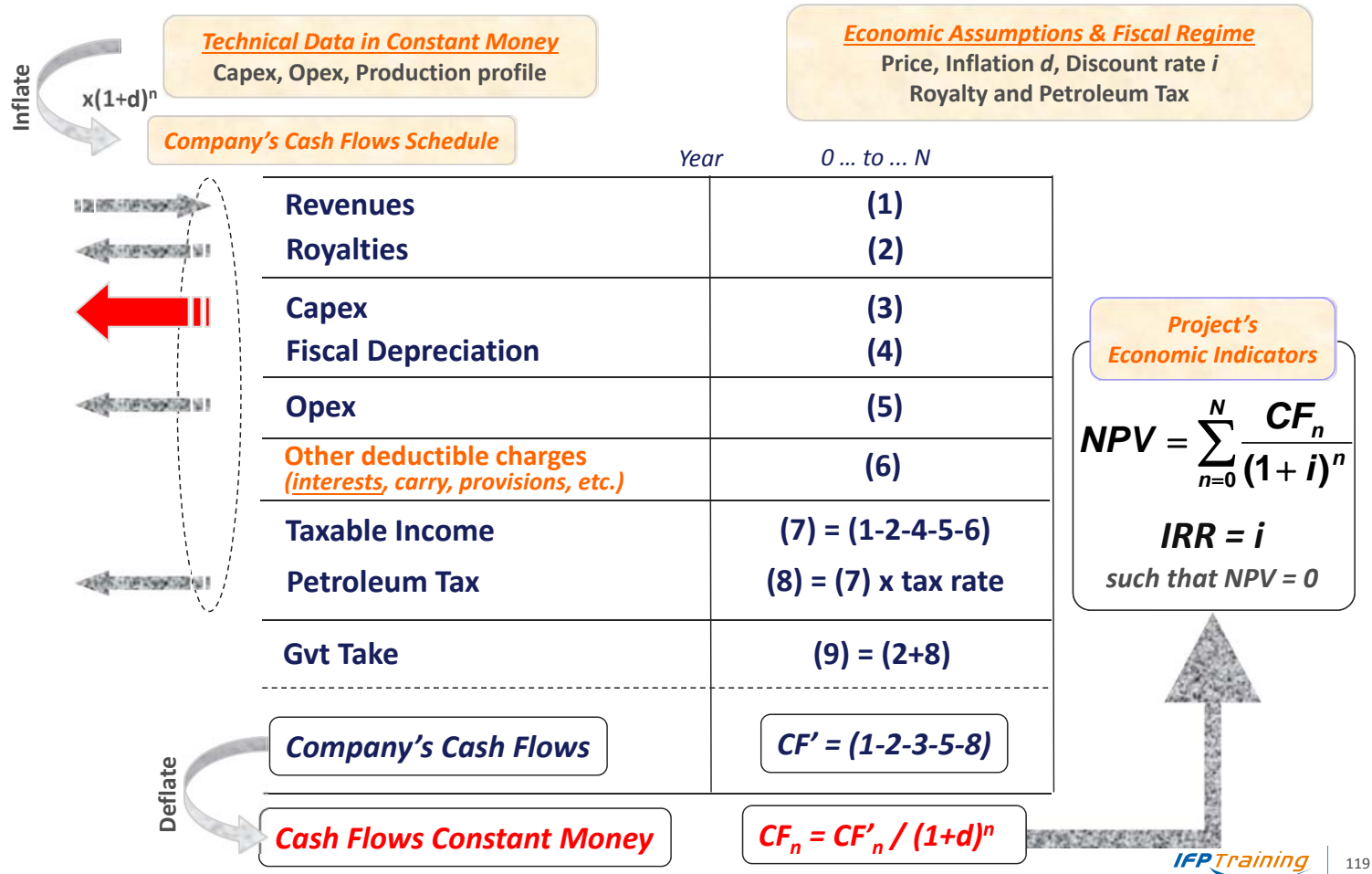
Discounting in nominal or constant money



Discount rates in nominal money and constant money

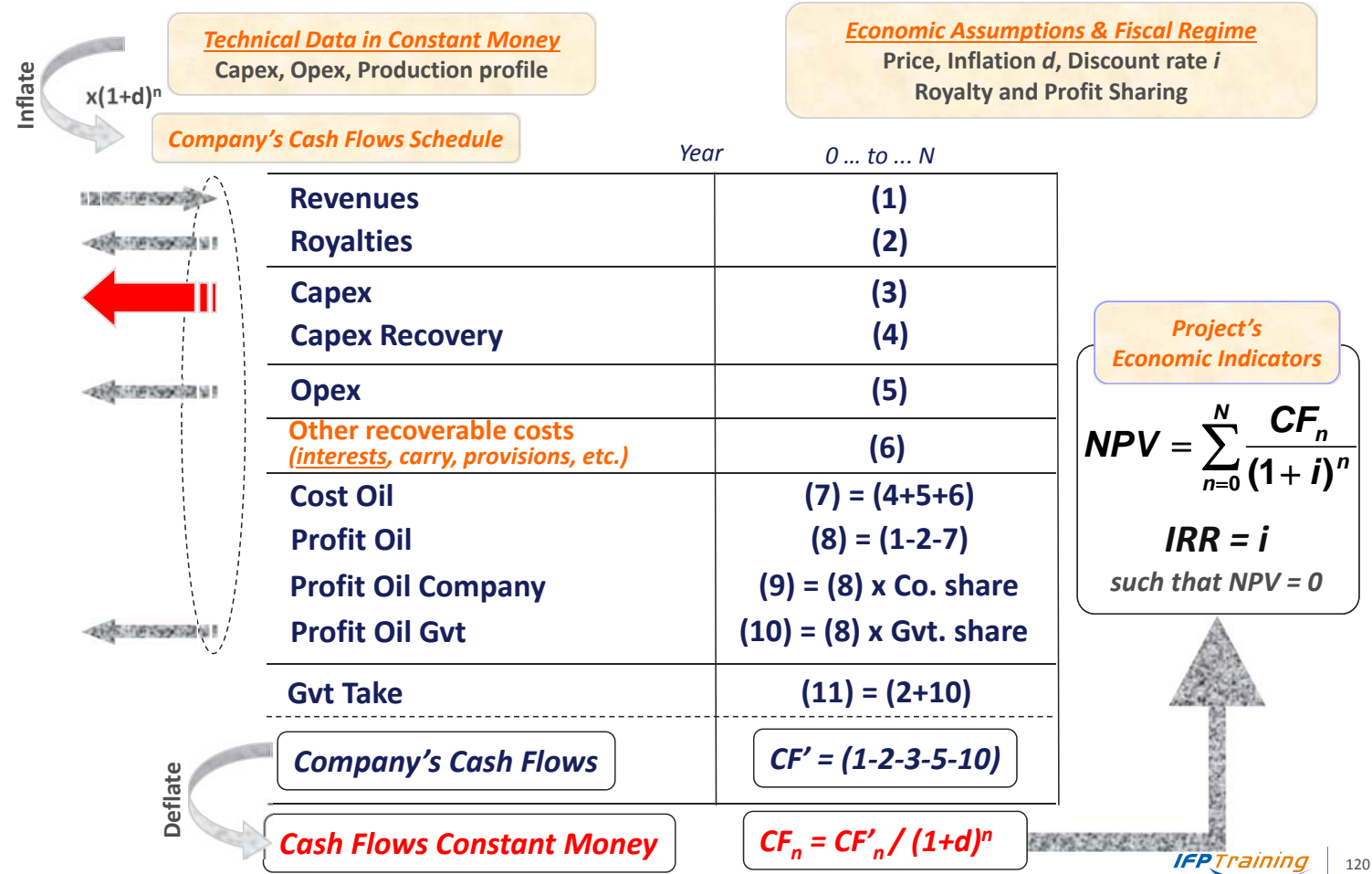


Global profitability analysis / Concession



119

Global profitability analysis / Production Sharing



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□ Fiscal Depreciation

- spreads the investment cost over the **depreciation period**.
- rules are **set in the petroleum contract**, depending on type of investment.
- depreciation is generally charged starting the **first year of exploitation**.
- Σ depreciation charges = nominal value of asset, except when there is an **uplift**.
- **straight-line depreciation**: constant depreciation charges = Capex / Nbre years

□ Consolidation

- a **negative taxable income** of a project is consolidated at the level of the company's result in the country. Provided the latter is positive, this will induce **tax savings** (or a tax shield) which must be credited to the project.

□ Ringfencing

- a **negative taxable income** of a project is a fiscal loss which is **carried forward** to the following fiscal year. It is then a **charge** which can be deduced in the computation of the taxable income.

Example to illustrate consolidation vs ringfencing

□ CONSOLIDATION

Year		0	1	2	3	4	5
Revenues	(1)		40	70	70	70	70
Capex	(2)	140					
Depreciation	(3)		35	35	35	35	
Opex	(4)		20	25	25	25	25
Income	(5)=(1-3-4)		-15	10	10	10	45
Tax	(6)=(5) * t		-6	4	4	4	18
Cash Flows	(7)=(1-2-4-6)	-140	26	41	41	41	27

□ RINGFENCING

Year		0	1	2	3	4	5
Revenues	(1)		40	70	70	70	70
Capex	(2)	140					
Depreciation	(3)		35	35	35	35	
Opex	(4)		20	25	25	25	25
Carry Forward	(5)			-15	-5	0	0
Income	(6)=(1-3-4)+(5)		-15	-5	5	10	45
Tax	(7)=(6)*t if >0		0	0	2	4	18
Cash Flows	(8)=(1-2-4-7)	-140	20	45	43	41	27

Case study: oil field development

TECHNICAL DATA CONSTANT MONEY (M\$ year 0)

100%	SUM	0	1	2	3	4	5	6	7	8	9	10	11	12
Crude Oil Production Mbbl	120						10	16	20	20	20	16	10	8
Appraisal Capex M\$	40		40											
Development Capex M\$	800			200	300	300								
Fixed Opex M\$	320						40	40	40	40	40	40	40	40
Variable Opex (\$/b)	4													
Variable Opex M\$	480						40	64	80	80	80	64	40	32
Total Opex M\$	800						80	104	120	120	120	104	80	72

ECONOMIC ASSUMPTIONS

Discount Rate (constant money)	11%	1.00	1.11	1.23	1.37	1.52	1.69	1.87	2.08	2.30	2.56	2.84	3.15	3.50
Inflation Rate	2%	1.00	1.02	1.04	1.06	1.08	1.10	1.13	1.15	1.17	1.20	1.22	1.24	1.27
Crude Oil Price (\$/b)	60	60.0	61.2	62.4	63.7	64.9	66.2	67.6	68.9	70.3	71.7	73.1	74.6	76.1

PRODUCTION SHARING

Royalty	30%
Cost Stop	40%
Profit Oil Sharing:	
Company	35%

CONCESSION

Royalty	30%
Petroleum Tax Rate	68%

Total Past Exploration Cost	100	M\$ recoverable
Cost Recovery or Fiscal Depreciation:		
Exploration & Appraisal Cost	100%	a year starting 1st year of production
Development Cost	20%	a year starting 1st year of production
Uplift for Development Cost	25%	

Case study: oil field development / Concession

CASH FLOW SCHEDULE MOD (M\$)

IOC's Share	100%	SUM	0	1	2	3	4	5	6	7	8	9	10	11	12
Revenues		8487						662.4	1 081.1	1 378.4	1 406.0	1 434.1	1 170.2	746.0	608.8
Royalty		2546						198.7	324.3	413.5	421.8	430.2	351.1	223.8	182.6

Total Capex	892		40.8	208.1	318.4	324.7									
Total Capex Depreciation	1205							353.6	212.8	212.8	212.8	212.8			

Operating Costs	945							88.3	117.1	137.8	140.6	143.4	126.8	99.5	91.3
-----------------	-----	--	--	--	--	--	--	------	-------	-------	-------	-------	-------	------	------

Taxable Income	3791							21.8	426.9	614.3	630.8	647.7	692.4	422.7	334.8
----------------	------	--	--	--	--	--	--	------	-------	-------	-------	-------	-------	-------	-------

Petroleum Tax	2577							14.8	290.2	417.5	428.8	440.2	470.6	287.4	227.6
---------------	------	--	--	--	--	--	--	------	-------	-------	-------	-------	-------	-------	-------

Company's Cash Flows	1527		-40.8	-208.1	-318.4	-324.7	360.6	349.5	409.5	414.8	420.2	221.8	135.4	107.2	
----------------------	------	--	-------	--------	--------	--------	-------	-------	-------	-------	-------	-------	-------	-------	--

Company's Cash Flows Cst Money	1234		-40.0	-200.0	-300.0	-300.0	326.6	310.4	356.5	354.0	351.6	181.9	108.9	84.6	
--------------------------------	------	--	-------	--------	--------	--------	-------	-------	-------	-------	-------	-------	-------	------	--

DCFlows	330		-36.0	-162.3	-219.4	-197.6	193.8	165.9	171.7	153.6	137.5	64.1	34.6	24.2	
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Deflate / $(1+d)^n$

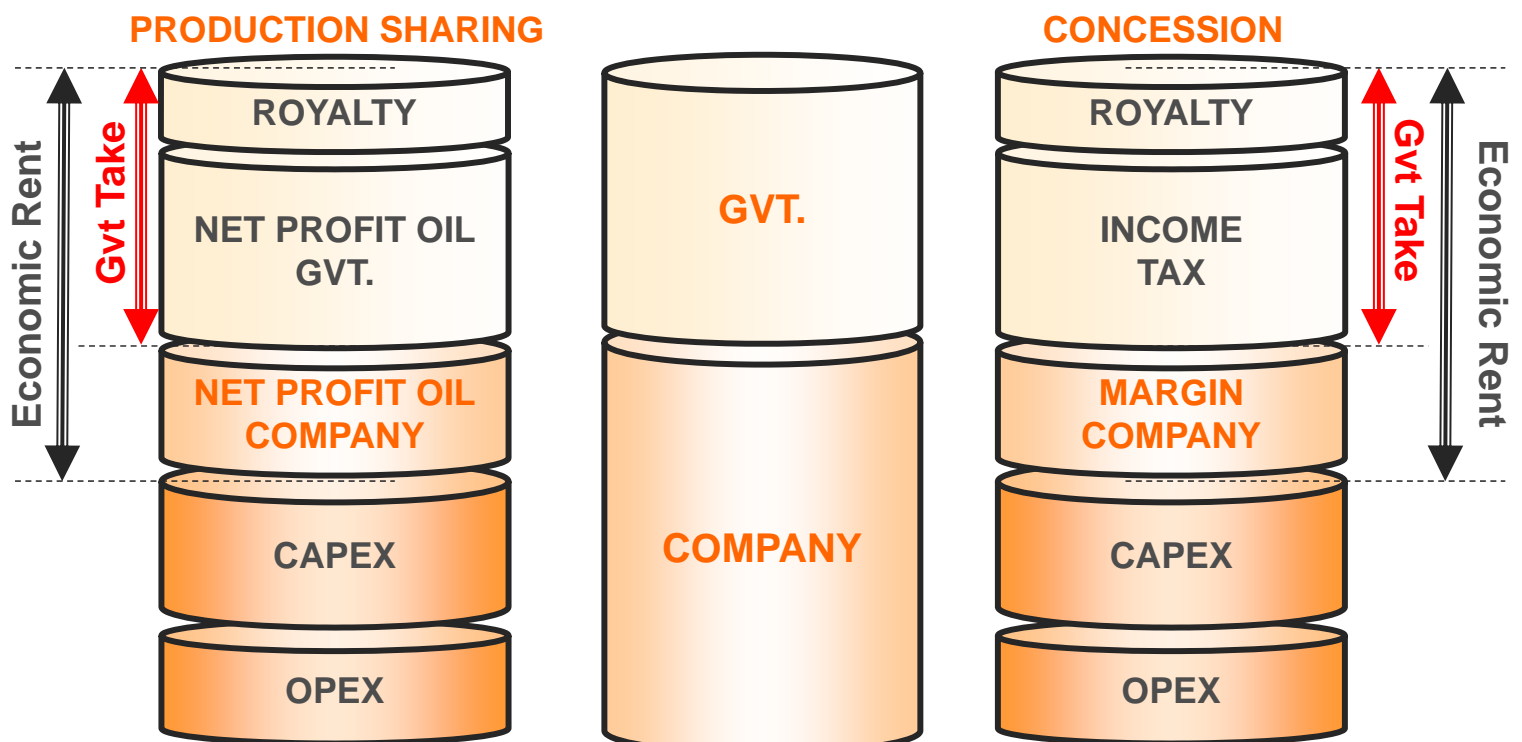
 Discount / $(1+i)^n$

Case study: oil field development / Production Sharing

CASH FLOW SCHEDULE MOD (M\$)

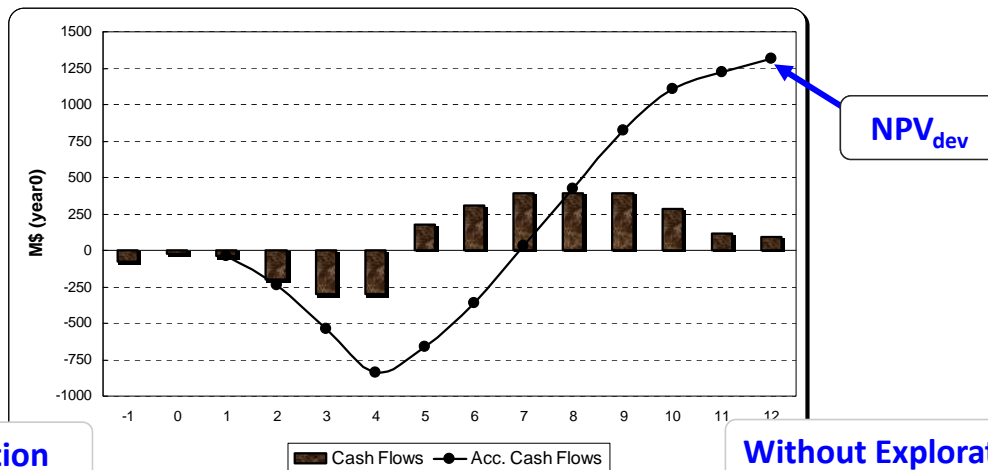
IOC's Share	100%	SUM	0	1	2	3	4	5	6	7	8	9	10	11	12
Revenues		8487						662.4	1 081.1	1 378.4	1 406.0	1 434.1	1 170.2	746.0	608.8
Royalty		2546						198.7	324.3	413.5	421.8	430.2	351.1	223.8	182.6
Total Capex		892		40.8	208.1	318.4	324.7								
Total Capex Recovery		1205						353.6	212.8	212.8	212.8	212.8			
Operating Costs		945						88.3	117.1	137.8	140.6	143.4	126.8	99.5	91.3
Cost Oil		2150						185.5	302.7	386.0	393.7	401.6	289.5	99.5	91.3
Profit Oil		3791						278.2	454.1	578.9	590.5	602.3	529.7	422.7	334.8
Contractor's Profit Oil		1327						97.4	158.9	202.6	206.7	210.8	185.4	148.0	117.2
State's Profit Oil		2464						180.8	295.1	376.3	383.8	391.5	344.3	274.8	217.6
Company's Cash Flows		1640		-40.8	-208.1	-318.4	-324.7	194.5	344.5	450.7	459.8	469.0	348.1	148.0	117.2
Company's Cash Flows Cst Money		1316		-40.0	-200.0	-300.0	-300.0	176.2	305.9	392.4	392.4	392.4	285.5	119.0	92.4
DCFlows		330		-36.0	-162.3	-219.4	-197.6	104.6	163.6	189.0	170.3	153.4	100.6	37.8	26.4

Results of a global profitability analysis



$$\text{PROFIT OIL COMPANY or MARGIN COMPANY (\$/b)} = \frac{\text{PROJECT'S VALUE (M\$)} / \text{FIELD'S RESERVES (Mb)}}{1}$$

Results of a field development project evaluation



With Exploration

$NPV@0\% = M\$1215$

$NPV@11\% = M\$220$

IRR = 17%

Financial Exposure = M\$942

$PI@0\% = 1.29$

Without Exploration

$NPV@0\% = M\$1316$

$NPV@11\% = M\$330$

IRR = 22%

Financial Exposure = M\$840

$PI@0\% = 1.57$

Results of a field development project evaluation

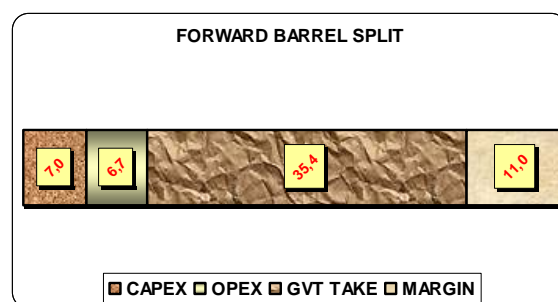
With Exploration



RENT SHARING

	(M\$)	SUM
Company's Cash Flows	22%	1215
State's Cash Flows	78%	4244
Total Cash Flows		5459

Without Exploration



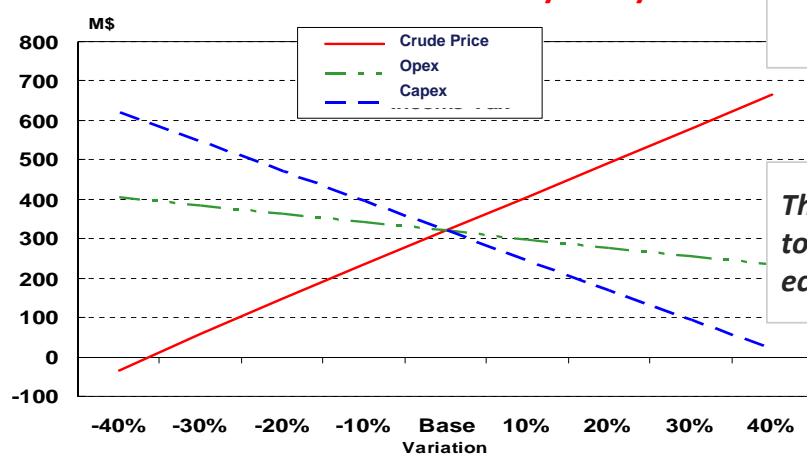
RENT SHARING

	(M\$)	SUM
Company's Cash Flows	24%	1316
State's Cash Flows	76%	4244
Total Cash Flows		5560

Methodology of Quantitative Risk Analysis

Sensitivity analysis for a development project evaluation

Net Present Value Sensitivity Analysis



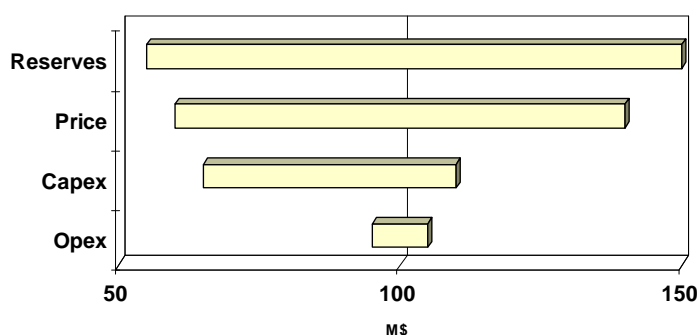
Spider Diagram

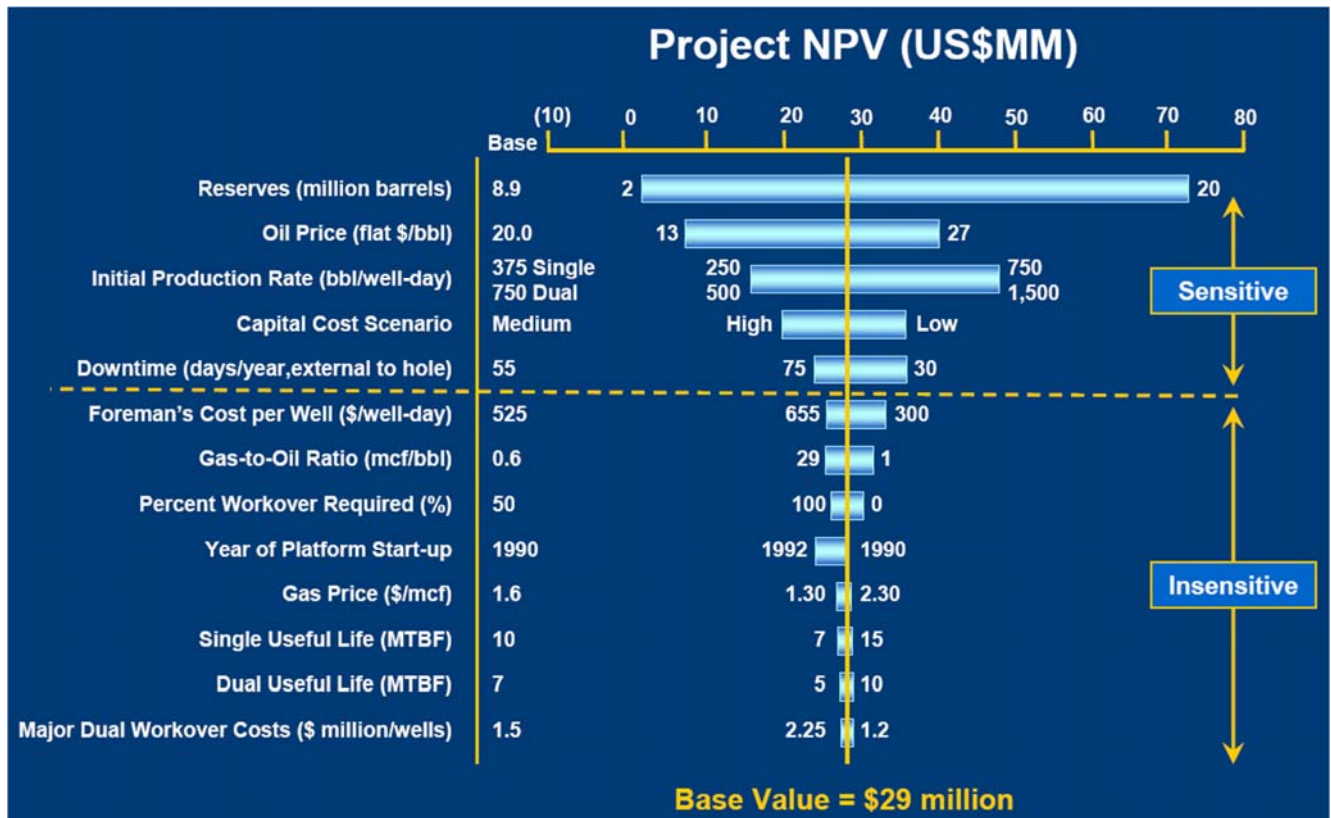
The variation of some **key risk factors** allows one to evaluate the **impact of those factors** on the economic indicators.

This analysis gives a better idea of the project's **potential** and **important risk factors**.

Tornado Diagram

Net Present Value Sensitivity Analysis





Risk analysis

- ❑ **Risk in the petroleum industry:** in general subjective. Estimating the probabilities associated with potential results demands often intuition with subjective and personal judgments.

- ❑ **Risk can be analyzed quantitatively.**

Such analysis is useful because:

- it forces the analyst to make a **more objective evaluation** of the factors affecting the data.
- it forces **assumptions to be reviewed and justified**.
- **complex decisions** with many alternatives can be investigated.
- assessing risk and uncertainty in probabilistic terms is a clear and concise way to **convey results to management**.
- it provides a **consistent method to compare investments** in different areas and with differing levels of uncertainty.

- ❑ Enables discovery of **maximum variations** consistent with **acceptability** of project.
- ❑ Procedure ignores **full dispersion** of possible outcomes and ignores **probabilities** attached to variations in primary variables.
- ❑ **Dependency** causes difficulties in a sensitivity analysis because it is then not strictly correct to consider errors in only one variable at a time. Two variables are dependent if a knowledge of the value of one would influence the estimates made for the other.
- ❑ A sensitivity analysis is a **useful first procedure** in evaluating the risks inherent in an investment opportunity.
- ❑ It can be regarded as a way of quickly identifying those variables which contribute most to the **risk** of the investment.

Methodology of quantitative risk analysis

Beyond sensitivity analysis

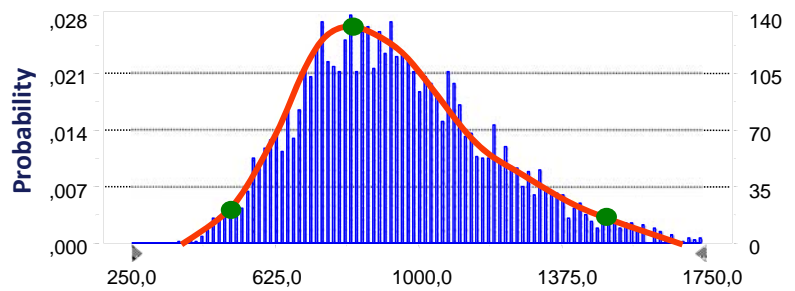
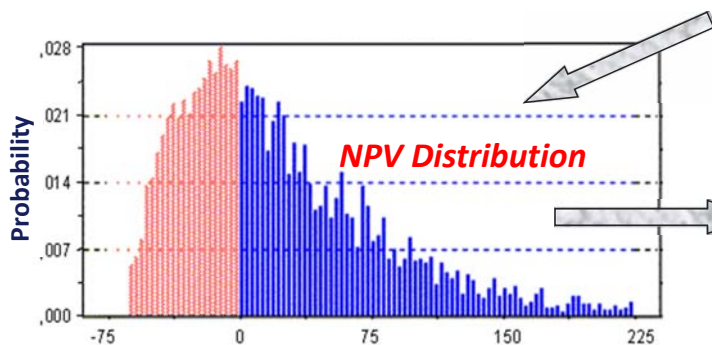
- ❑ **Identify key variables** which contribute most to the project's risk and examine them more in detail.
- ❑ If necessary, assign to the key variables **ranges of values and probability distributions**, discrete or continuous, for a complete description of uncertainties.
- ❑ Conduct an **evaluation**, and recommend the **best alternative** consistent with guidelines and constraints set by the management.

Methods

- Monte Carlo Simulation
- Decision Tree Analysis
- Scenarios Approach

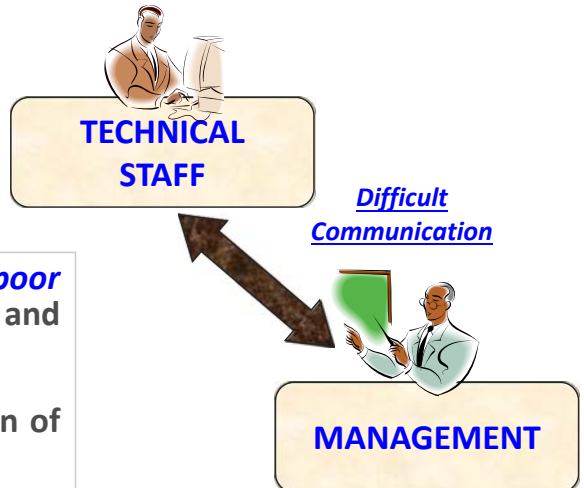
Continuous probabilistic approach:

Monte Carlo simulation



Project's Economic Value = Weighted Average

- ❑ Problem of **dependency** between variables and **poor optimization** of options for the development architecture and production profiles.
- ❑ **Black box effect**: impossible to **identify** the contribution of a given input to the output value.
- ❑ This is a **critical drawback** for **experts** and **managers**.

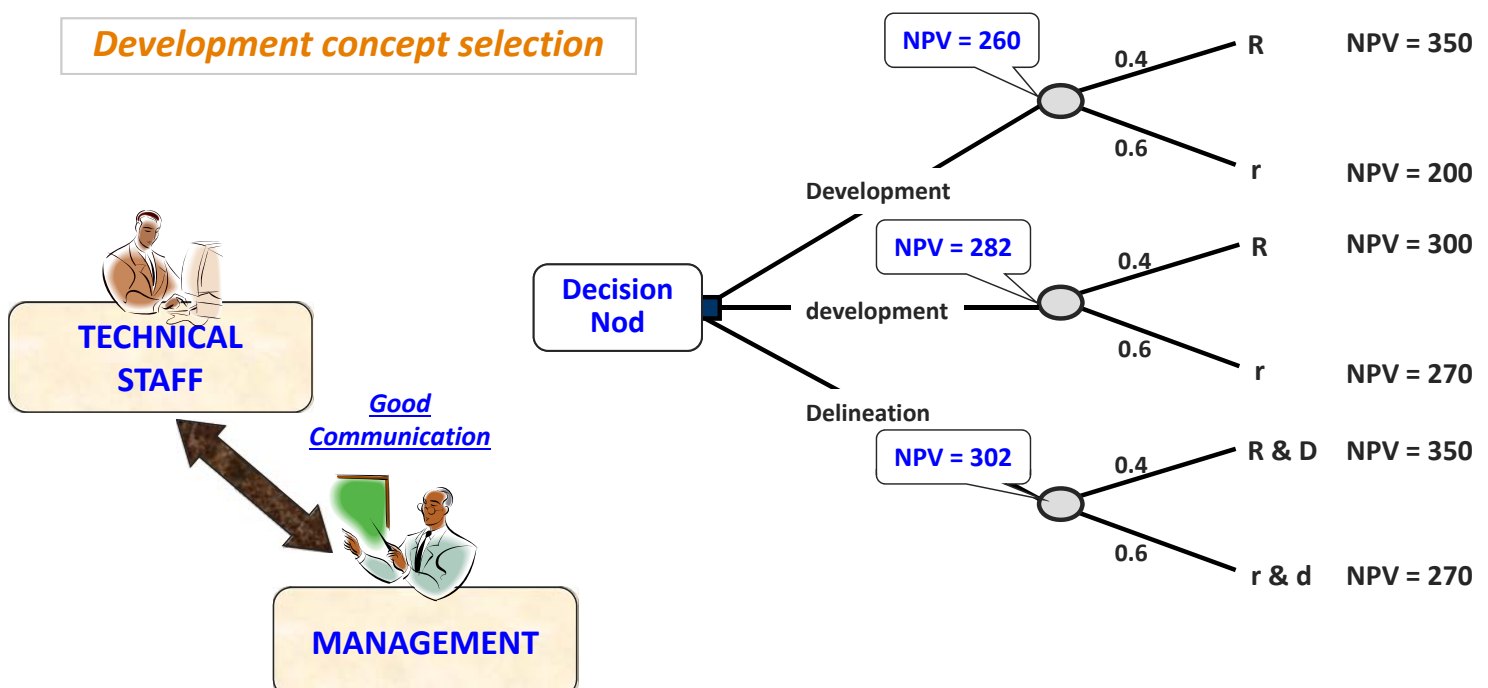


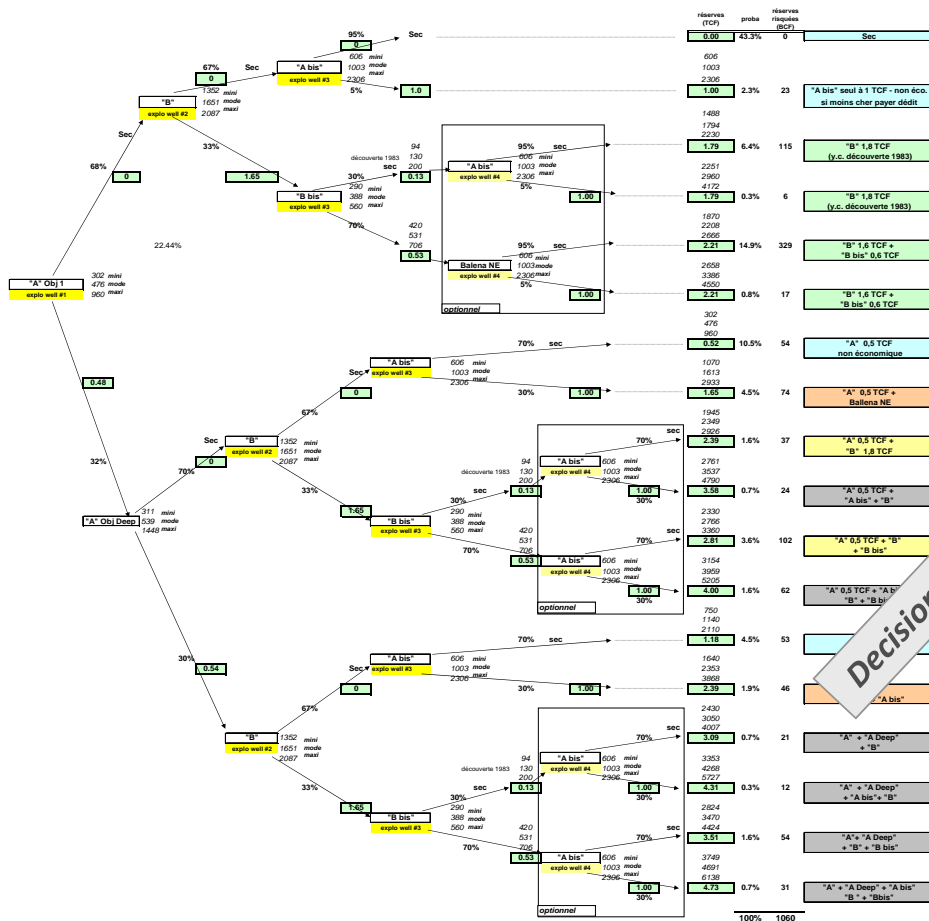
Discrete probabilistic approach: Decision tree analysis

Decision Tree Analysis

to catch, in a simple way, the flexibility available to management in adjusting its decisions depending on the actual outcome of some risk factors.

Development concept selection



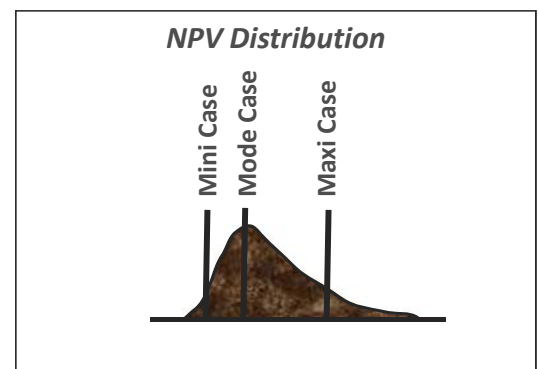


Decision trees can rapidly become very complex.

Decision theory model: Scenarios approach

A decision problem can be described with a natural approach through **three deterministic scenarios**:

- “Min” or “pessimistic” scenario NPV_{min}
- “Mode” or “most probable” or base scenario NPV_{mode}
- “Max” or “optimistic” scenario NPV_{max}



DECISION THEORY

Mean Net Present Value

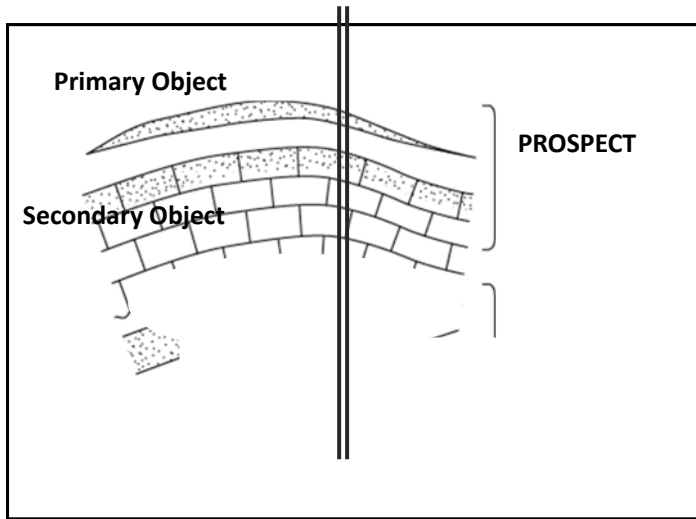
$$\text{Mean NPV} = \langle NPV \rangle \cong 0.3 NPV_{min} + 0.4 NPV_{mode} + 0.3 NPV_{max}$$

(Swanson's Rule)

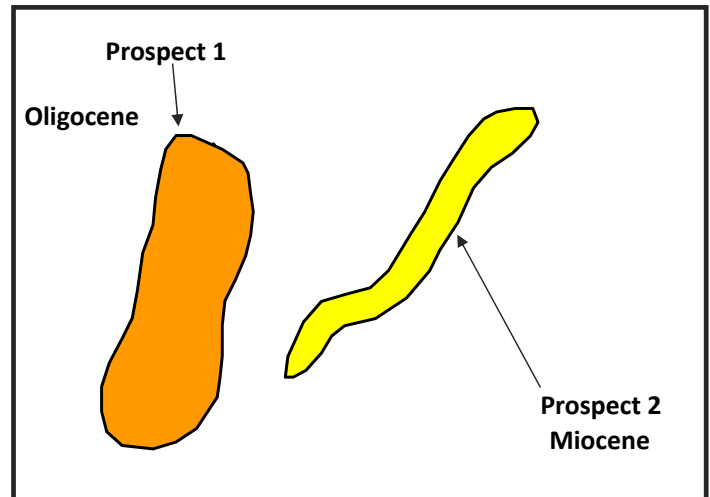
with a measure of the risk provided by the standard deviation

$$\sigma \cong 1/3 (V_{max} - V_{min})$$

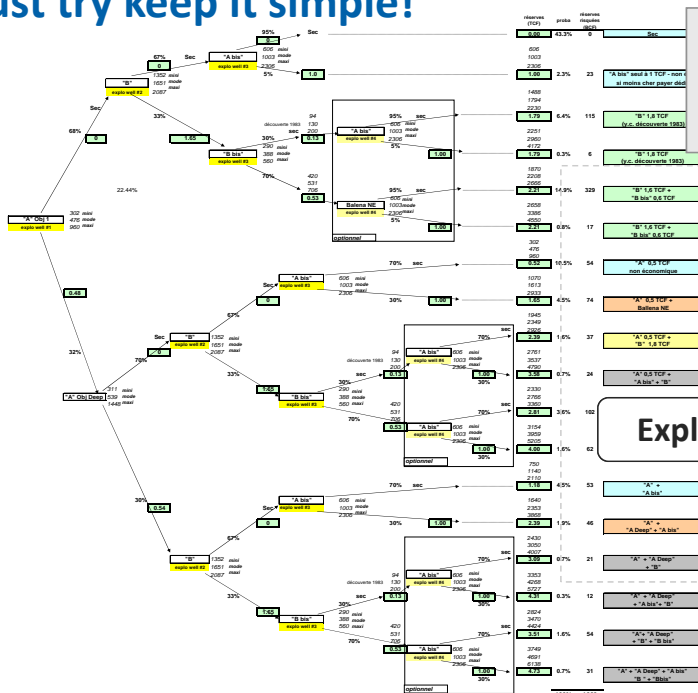
Multi Objectives / Mono Prospect one well



Multi Prospects several wells



Scenarios approach for complex exploration projects: just try keep it simple!



Decision trees can rapidly become very complex. Engineers and economists work hard together to try to keep it simple!

Reserves Probability Distribution

- P10 Case
- P50 Case
- P90 Case

Explore

PS

1 - PS

Dry Branch

Mean Expected Net Present Value

$$\text{Mean ENPV} \cong 0.3 \text{ ENPV}_{P10} + 0.4 \text{ ENPV}_{P50} + 0.3 \text{ ENPV}_{P90}$$

$$\text{Mean ENPV} \cong 0.3 \text{ PS} \cdot \text{NPV}_{P10} + 0.4 \text{ PS} \cdot \text{NPV}_{P50} + 0.3 \text{ PS} \cdot \text{NPV}_{P90} + (1 - \text{PS}) \text{ NPV}_{\text{dry}}$$

Exploration project with two prospects

Reserves (MMb)

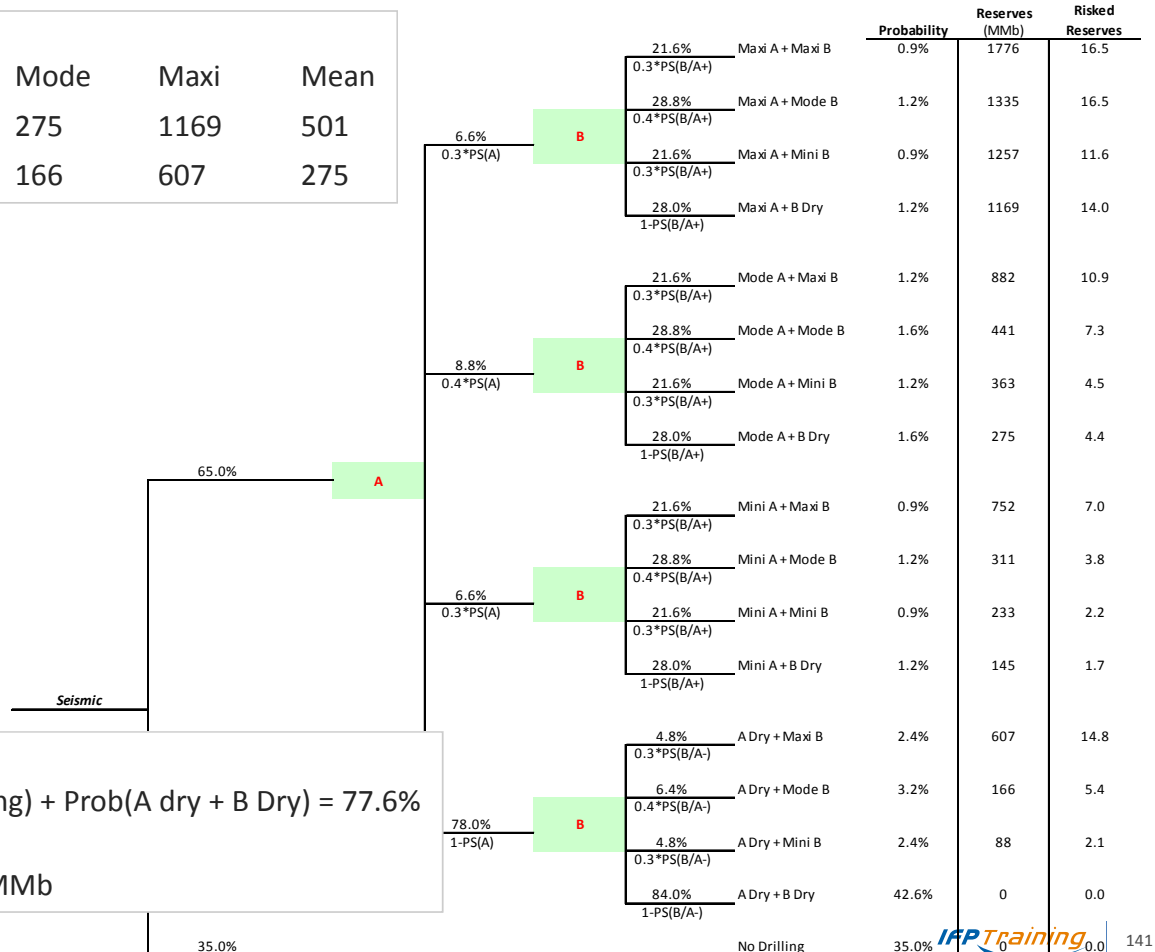
	Mini	Mode	Maxi	Mean
Prospect A	145	275	1169	501
Prospect B	88	166	607	275

Probabilities

- $PS(A) = 22\%$
- $PS(B/A+) = 72\%$
- $PS(B/A-) = 16\%$
- $PS\text{ seismic} = 65\%$

Results

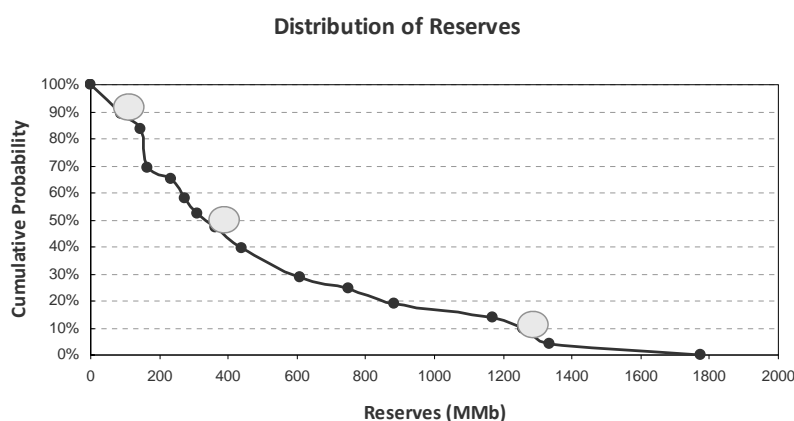
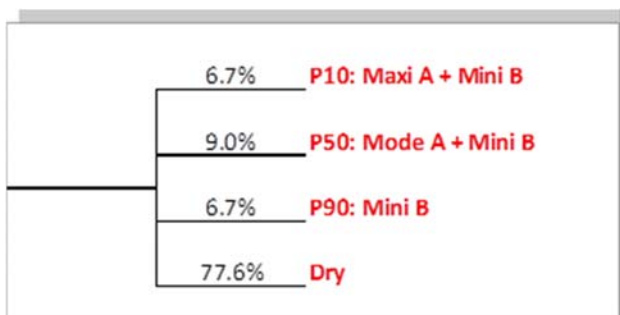
- Prob. Dry = Prob(NoDrilling) + Prob(A dry + B Dry) = 77.6%
- $PS\text{ Global} = 22.4\%$
- Risked reserves = 122.7 MMb



Exploration project with two prospects

	Probability	Reserves	Probability to find a volume > X
Maxi A + Maxi B	0.9%	1776	0.0%
Maxi A + Mode B	1.2%	1335	0.9%
Maxi A + Mini B	0.9%	1257	2.2%
Maxi A + B Dry	1.2%	1169	3.1%
Mode A + Maxi B	1.2%	882	4.3%
Mini A + Maxi B	0.9%	752	5.5%
A Dry + Maxi B	2.4%	607	6.5%
Mode A + Mode B	1.6%	441	8.9%
Mode A + Mini B	1.2%	363	10.5%
Mini A + Mode B	1.2%	311	11.8%
Mode A + B Dry	1.6%	275	13.0%
Mini A + Mini B	0.9%	233	14.6%
A Dry + Mode B	3.2%	166	15.5%
Mini A + B Dry	1.2%	145	18.8%
A Dry + Mini B	2.4%	88	20.0%
No Drilling	35.0%	0	22.4%
A Dry + B Dry	42.6%	0	PS Global
	100.0%		

If Successful,
Probability to have a Volume > X
= Probability to find a Volume > X / PS Global



Closer Look at Why Projects Fail

Large project management in oil and gas

- ▶ Large projects in the oil and gas industry
 - daunting challenges, increasingly complex, technologically demanding
 - schedules and budgets are tight
 - safety is crucial
 - concern about impact on the environment and communities
- ▶ Project managers still rely on the concepts:
 - work breakdown plans
 - design-to-cost
 - make-or-buy decisions.
- ▶ Best practices and experienced talent: essential but not enough

Successful managers of large projects follow a coherent, consistent reference framework that guides their decisions and processes

Successful project management (1/2)

▶ 1/ Project management

Manage trade-offs among costs, schedule, technical solutions and stakeholder requirements to ensure the project's value

▶ 2/ Local Content and other stakeholders

Ensure proper alignment with stakeholders while meeting requirements to use local content and contractors

▶ 3/ Costs and Schedule

Provide an accurate estimate and control of project results, from concept to completion, monitoring project costs and schedule

▶ 4/ HR and Support Functions

Manage resources, training and compensation to ensure that the necessary skills are available to the project when needed

▶ 5/ Production Operations

Take into account all aspects of the asset's operability and maintenance, from planning through commissioning, start-up and performance tests

Successful project management (2/2)

▶ 6/ Engineering

Identify technologies that deliver innovation and competitive advantage in terms of quality, costs and schedule while avoiding over-engineering

▶ 7/ Procurement

Source goods and services based on best market opportunities

▶ 8/ Contracting

Define and manage contracts to meet quality, costs and schedule requirements

▶ 9/ Risk and Opportunity Management

Minimize the probability and consequence of threats while maximizing opportunities in a systematic and constantly updated process

▶ 10/ Quality and HSE

Guarantee the health and safety of employees, contractors, customers, local communities and the environment throughout the project life cycle

Focusing on

managing major projects in their most strategic aspects

could make a major contribution

► Thus, greater focus on the design phase of megaprojects

- strategic execution definition / cost estimates
- selection of alternatives / preliminary analysis of engineering

Front-End Planning

is the process of analyzing and explaining the goals and strategies needed to drive the project to a successful end throughout its life cycle

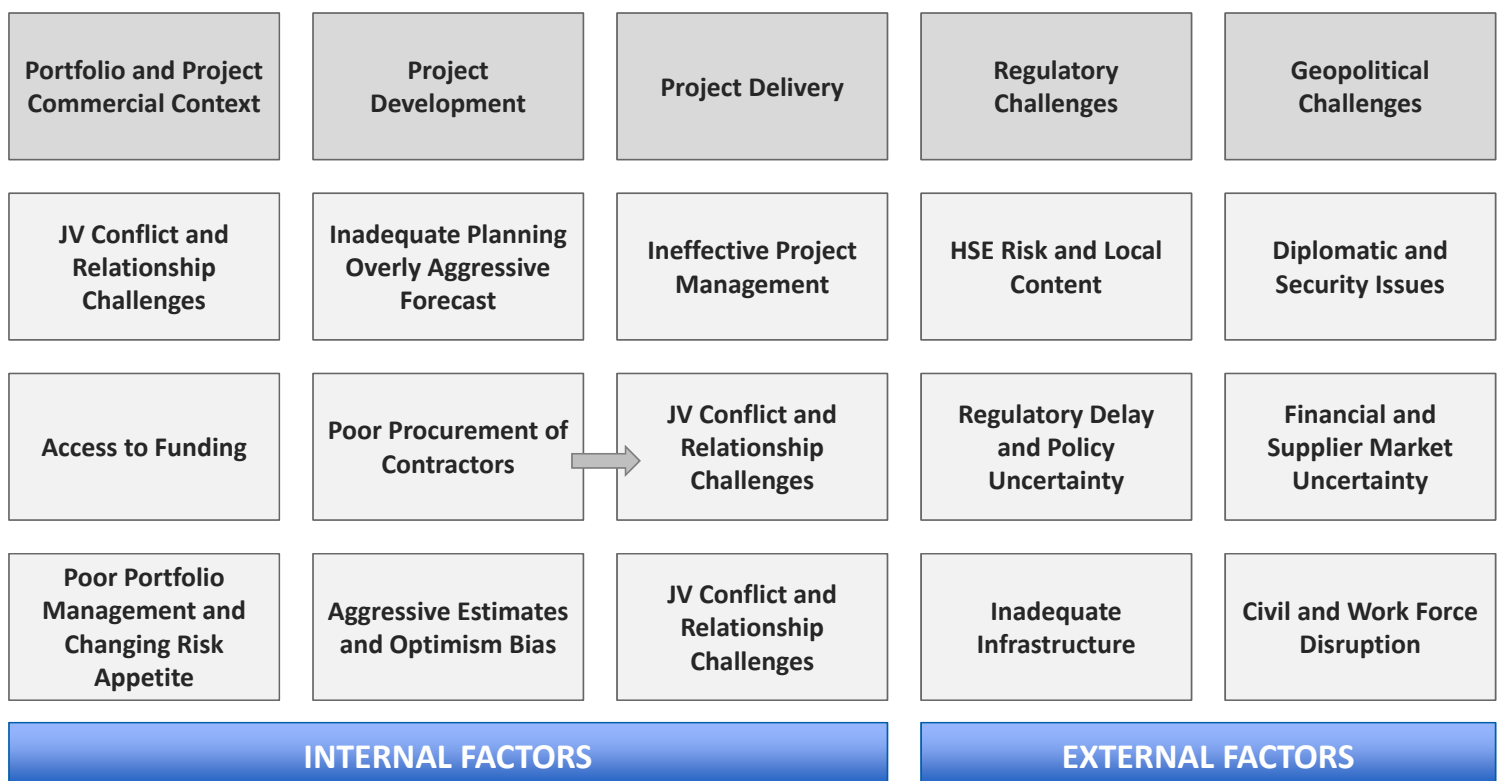
it begins with the conception of the project,

information generation and consolidation of the views of stakeholders,

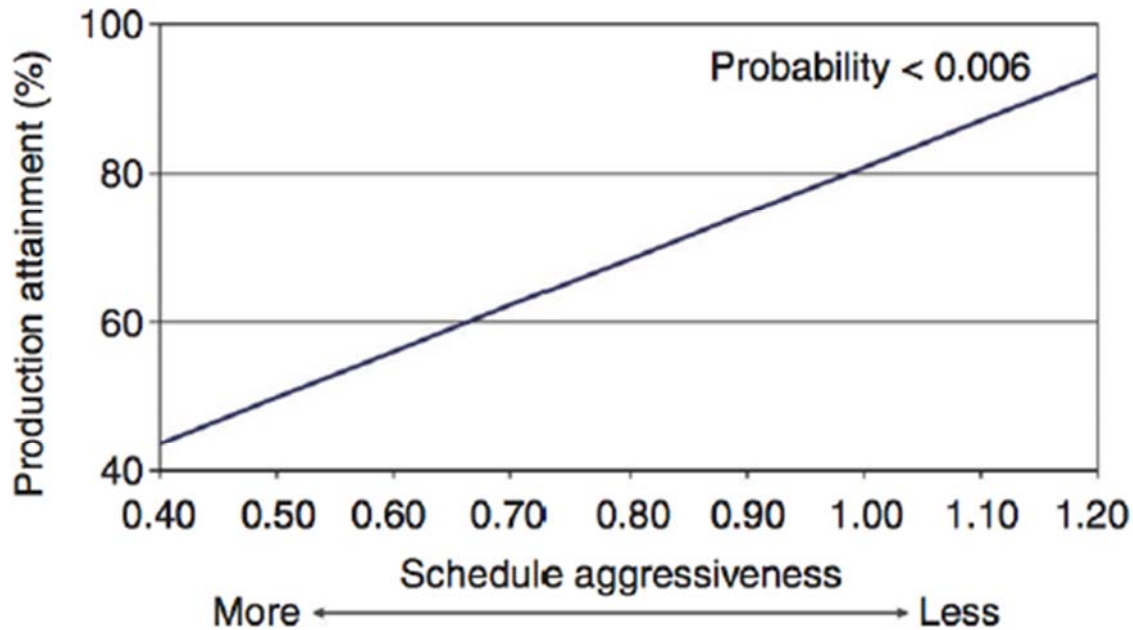
and ends with the final decision

whether the project will be executed or not.

Reasons for project overruns



Aggressive schedules result in lower than planned production



Schedule Aggressiveness =

Planned execution schedule at project sanction /
Industry schedule benchmark for projects of a similar nature

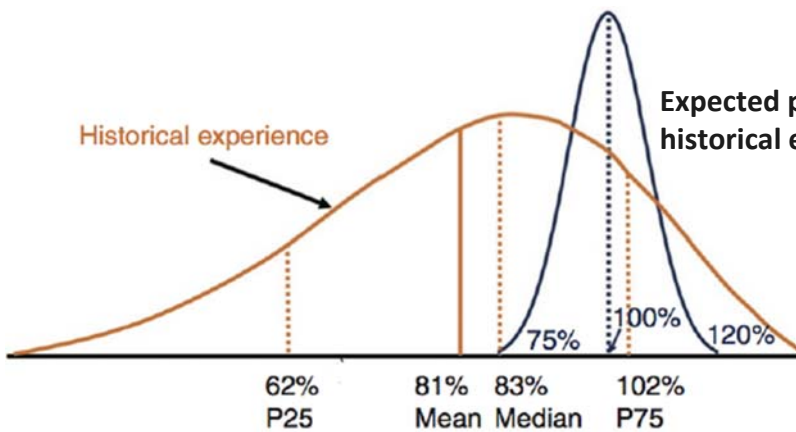
Aggressive pursuit: another issue in E&P projects

- ▶ **Search for valuable resources** requires taking **risks** and **capital investment**
- ▶ Companies want to ensure the best possible **return on investment: minimize time to first oil** so that the economic value of an investment is maximized.
- ▶ This leads to more **aggressive schedules**, which in turn leads to **trade-offs** being made to **meet the deadline**.
- ▶ Important phases are shortened: there is **less time** to acquire the **proper data** needed for teams to make **fully informed decisions**.
- ▶ **FASTER** schedules do **MORE** harm than **GOOD**
- ▶ An aggressive schedule only works when there is a **clear strategy** about how to achieve this aggressive schedule.

Facts:

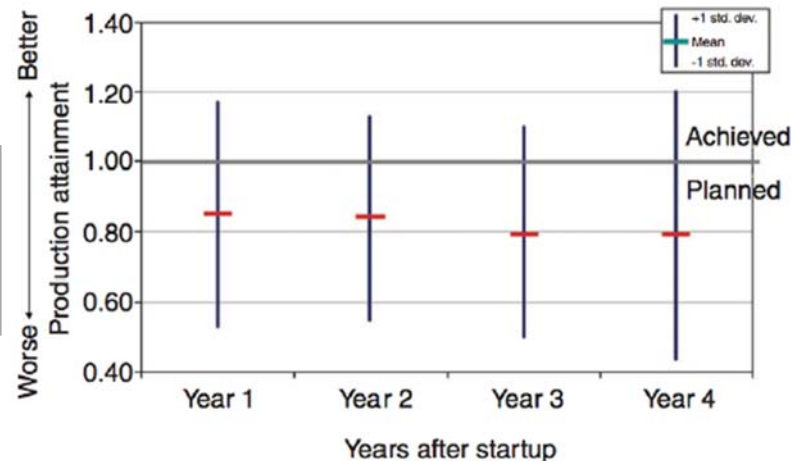
From 2003 to 2011, 54% of authorized E&P projects were planned with a schedule that was faster than similarly scaled projects
25% increase in the failure rate of E&P projects over the last 2 decades

Overconfidence: another issue in E&P projects



Overconfidence: on average, project teams expect to deliver from 75% to 120% of their planned production, but the actual mean is only 81%.

Failure to meet production forecast is not just in the immediate aftermath of first oil: even after years of production, the actual volumes fall short of those projected.



Making Front-End Planning useful

Owners need to make the

**people who will be vital to execution
an equally vital part of the frontend definition**

and get their input on what they are capable of producing.

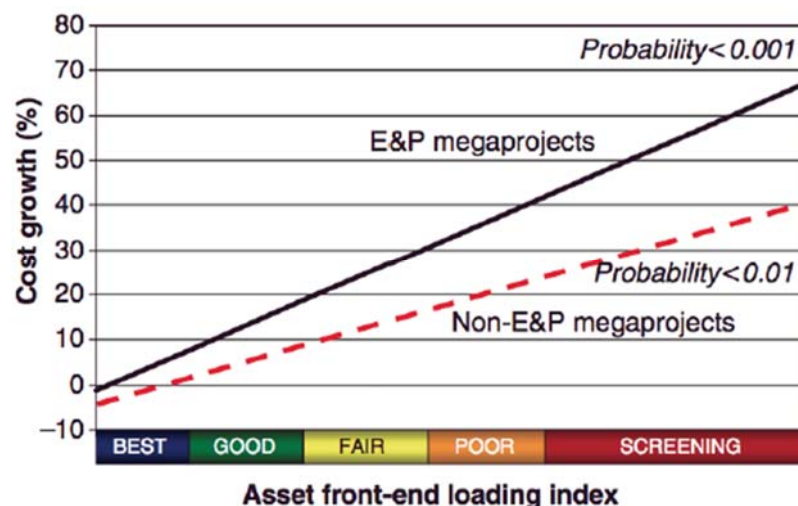
But there is a trade-off at play

- Prior to sanction, the project does not exist. There may not be enough to bring in a contractor, a construction manager, or a procurement team.
- Bringing in extra people early in the process could have significant financial results if the project does not get sanctioned.

Front-End Loading Purpose and Methodology

Understanding and planning for risks

- ▶ The big issue is all about understanding risks and then planning appropriately how to manage them. **The best tool for managing risk is knowledge.**
- ▶ The best way of effectively influencing the outcome of a project is through **early and thorough planning.**
- ▶ One can take out a lot of risk by understanding and performing a whole range of actions in the planning phase.



As the quality of front-end work decreases, the cost overruns rise

► Front-End Planning method different classifications

- Pre-Project Planning (PPP)
- Front-End Planning (FEP)
- Front-End Loading (FEL)
- Front-End Development (FED)
- Front-End Engineering Design (FEED)
- Front-End Decision Making (FEDM).

► For **IPA** (Independent Project Analysis)

FEL is the process by which a company translates its technology and market opportunities into capital projects. The purpose of FEL is to align project goals with business needs and to develop the most efficient execution plan to achieve the project objectives.

► For **CII** (Construction Industry institute)

FEP is the process of developing sufficient strategic information with which you can define project risks and decide how to allocate resources to maximize your chances of success.

Front-End Planning phases

Phase 1

FEL 1-Business Planning

FEP 1-Feasibility

FED 1-Assess

Identify

Opportunity Identification

Business Analysis

Phase 2

FEL 2-Scope Development

FEP 2-Concept

FED 2-Select

Select

Alternative Selection

Alternative Selection

Phase 3

FEL 3-Project Planning

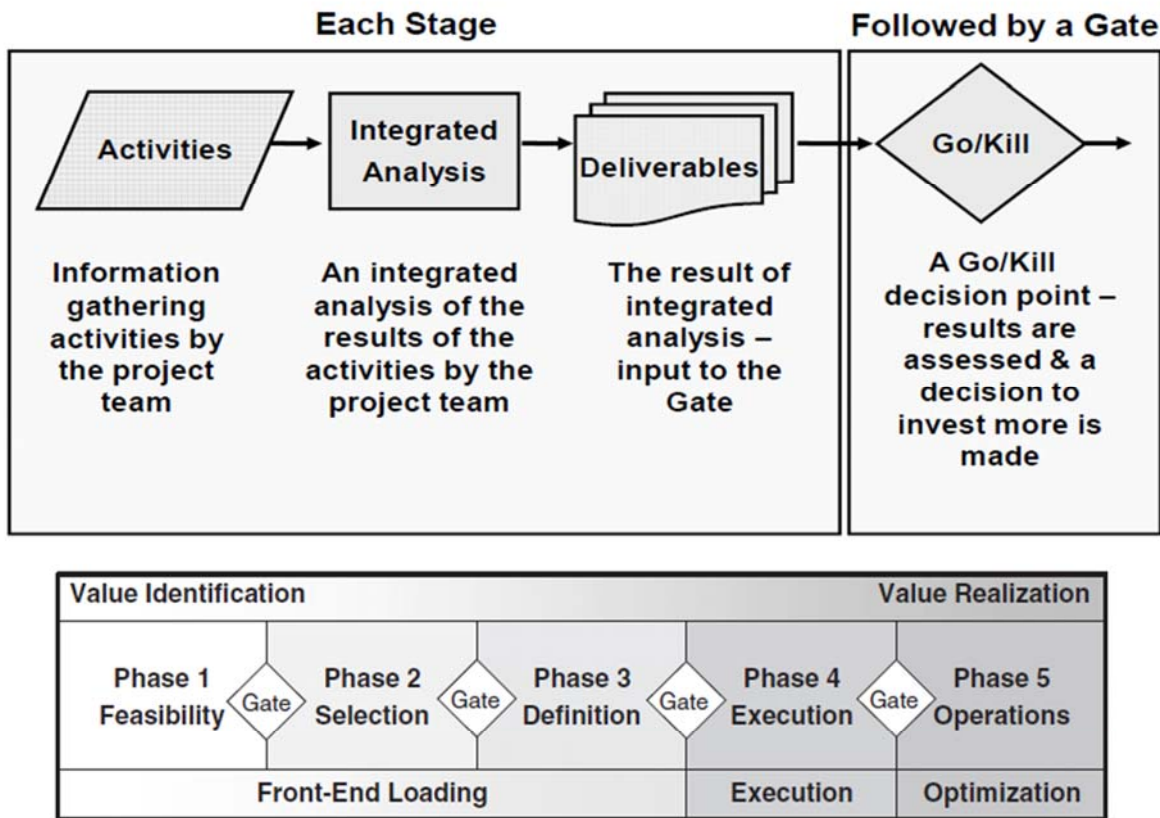
FEP 3-Detailed Scope

FED 3-Define

Develop

Project Definition

Construction and Operation Planning



Front-End Loading (FEL)



- ▶ FEL is the process for **conceptual development** of projects that involves developing sufficient **strategic information** with which owners can **address risk** and **make decisions** in order to maximize the potential for **success**

FEL includes robust planning and design early in a highly capital intensive project's lifecycle (i.e., the front end of a project), at a time when the ability to influence changes in design is relatively high and the cost to make those changes is relatively low

- ▶ FEL uses a **stage-gate process**, whereby a project must pass through formal gates at well defined milestones within the project's lifecycle before receiving funding to proceed to the next stage.
- ▶ The quality of front-end planning can be improved through the use of **PDRI (Project Definition Rating Index)** as a part of the stage-gate process.

FEL is usually followed by detailed design or detailed engineering



- ▶ Best opportunity to make a positive impact on the life-cycle of a major project is during the early conceptual and planning stages – well before the capital expenditures occur
- ▶ Better predict future risks by considering the long-term effect of the entire project
- ▶ Allocate risk and control the project's value chain
- ▶ Balance between risk allocation and value retention

FEL is the key to any successful project.

FEL is the process for conceptual development of projects and refers to

- pre-project planning stage
- feasibility analysis
- conceptual planning
- front-end engineering and design (FEED), and
- early project execution planning

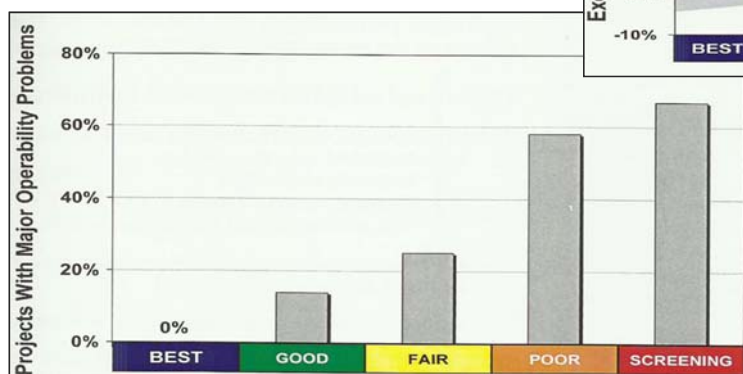
Front-End Loading: benefit

All major project outcomes are positively correlated with FEL Index at authorization



The definition of good front-end loading is 'best practical', not 'best possible'.

Doing too much FEL can also waste time and money at the start of the project.



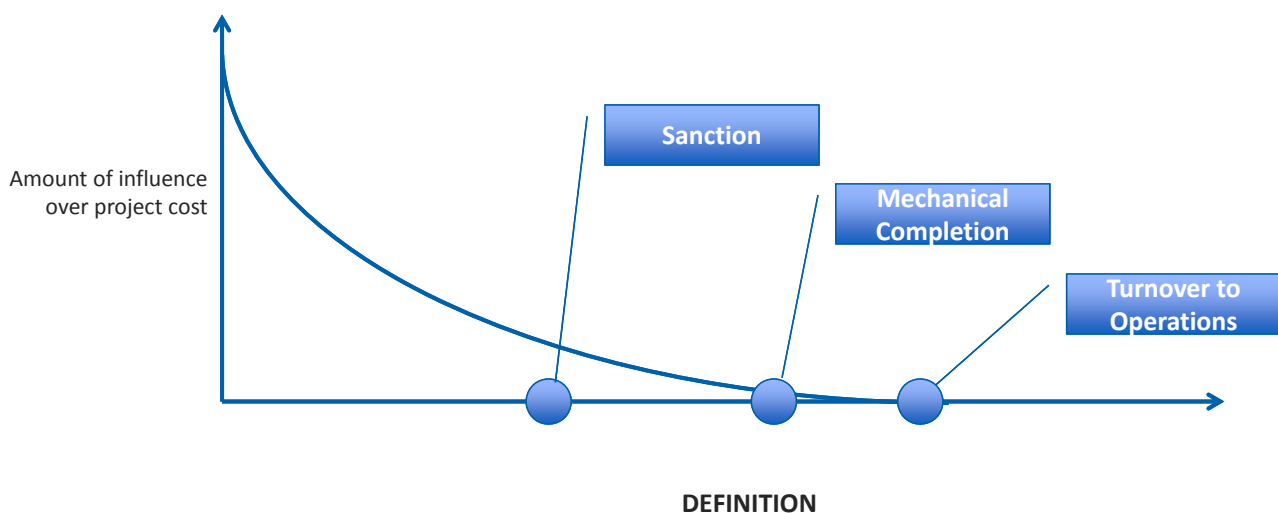
Front-End Loading practices are based on the assumption that project definition is the primary driver of cost outcomes

- ▶ But implementing best Front-End Loading practices does not guarantee the project meets its objectives
- ▶ Most major projects remain unsuccessful in terms of
Scope / Cost / Schedule / Business benefits

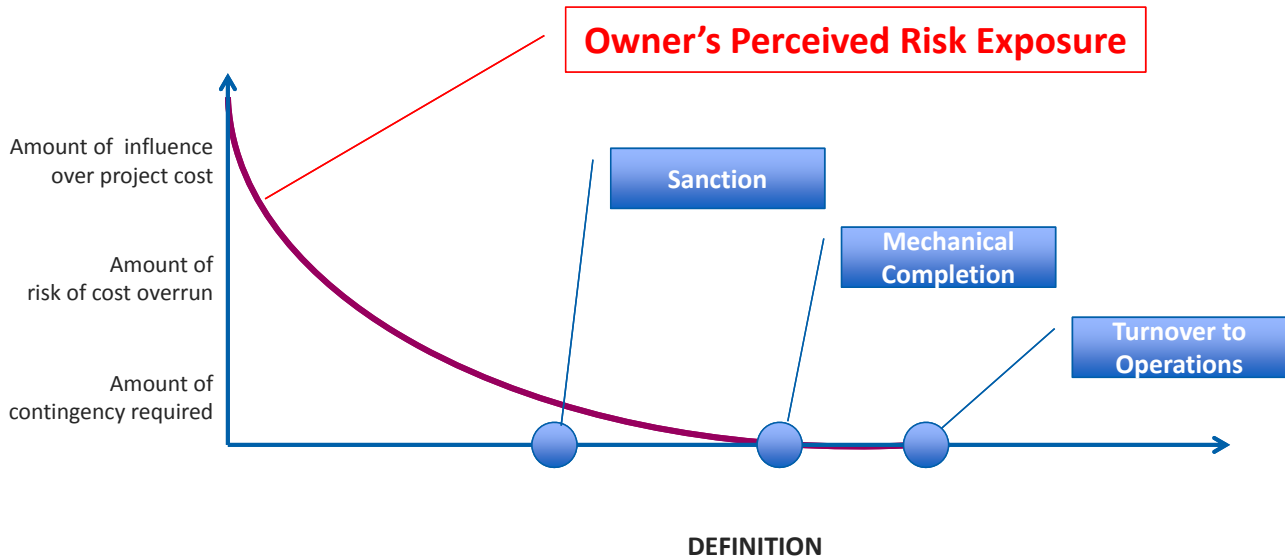
Front-End Loading best practices provide a false sense of security and fail to address many of the most critical risk and success factors of today's mega-projects

Influence curve: foundation of Front-End Loading

- ▶ **As the degree of project definition increases, the amount of influence over the project's outcomes decreases.**
- ▶ This is what leads to the **principle of FEL**, namely the more completely a project is defined, the less likely it is to experience **cost and schedule overruns**.



As a result, it has become generally accepted that the **owner's exposure to cost overrun risks** follows the same trend: highest at the start, acceptable at sanction, and decreasing steadily until turnover is completed.



Risk exposure is determined by a lot more factors than project definition

Concept of risk exposure has to be thought of in three areas:

- Amount of control
- Organizational and external sources of risk
- Compounding of risks during execution

Conventional definition of the expected value of a given risk:

$$\text{Risk Exposure} = \text{Potential Loss (\$)} \times \text{Probability of Occurrence}$$

This ignores an important factor:

amount of control = extent to which the parties can **influence**
the Potential Loss and/or the Probability of Occurrence

Risk exposure should be thought of as a function of the degree of control:

$$\text{Risk Exposure} = \text{Potential Loss (\$)} \times \text{Probability of Occurrence} \times 1/\text{Control Factor}$$

During FEL

the work is mostly engineering services, the level of expenditure is very low relative to the total project cost, and the level of control relatively high.

Therefore,

$$\text{Risk Exposure} = \text{LOW}$$

During Execution

Soon after sanction, contracts and purchase orders are signed.

Level of commitment and expenditures go up rapidly.

Contractors and suppliers increasingly have the upper hand.

Owner becomes more and more committed to the project.

- ▶ At this point, the time and cost of contract disputes are likely to have a greater impact on the project's economics than the amount of money in dispute.

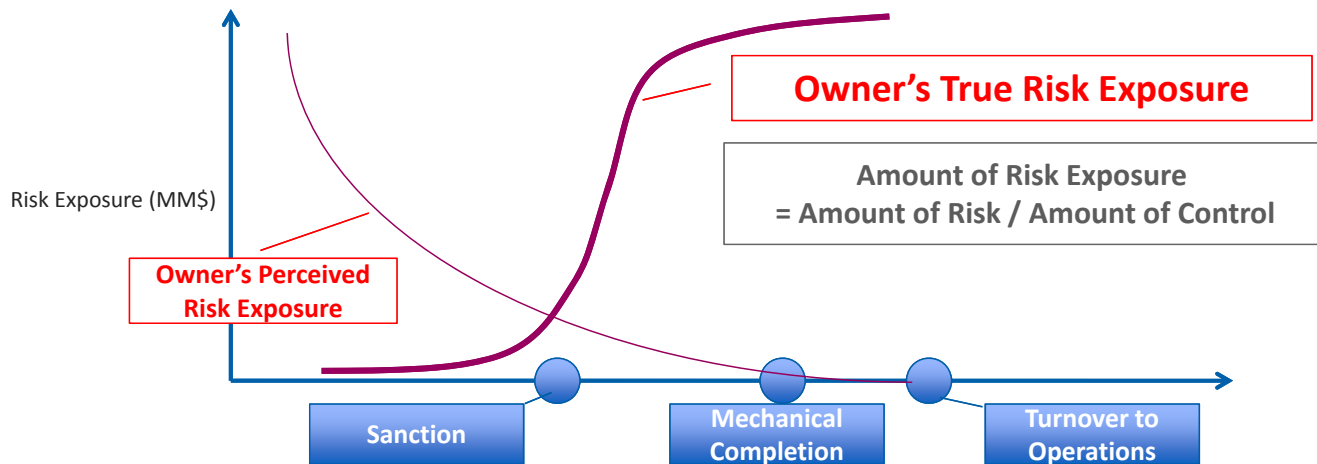
As a result,

the owner's risk increases rapidly while degree of control becomes less.

Therefore,

$$\text{Risk Exposure} = \text{MODERATE increasing to HIGH}$$

- ▶ The Influence curve is correct: after sanction, influence (or control) is less. That is why true risk exposure is actually higher.



Risk exposure / organizational and external sources of risk

*Organizational and external risks tend to manifest themselves during execution.
Another reason why owner's true risk exposure increases significantly after sanction.*

Best Practice Focus		
Risk Exposure	HIGH	Economic and Geopolitical Conditions
		Owner and Contractor Competencies
	LOW	Definition and Execution
		Project Risks
		Organizational Risks
		External Risks

Risk exposure / compounding exposure during execution

Engineering, Procurement and Construction each have their own risk exposure profile reflecting the amount of risk and control over time.

- ▶ **Engineering:** risks associated with productivity, management of change, and location factors.
- ▶ **Procurement:** risks associated with pricing and commercial terms, timely production of vendor drawings, quality and delivery lead times.
- ▶ **Construction:** risks associated with labor availability and productivity, site access and conditions, and the quality of supervision.

These Risks are Not Independent

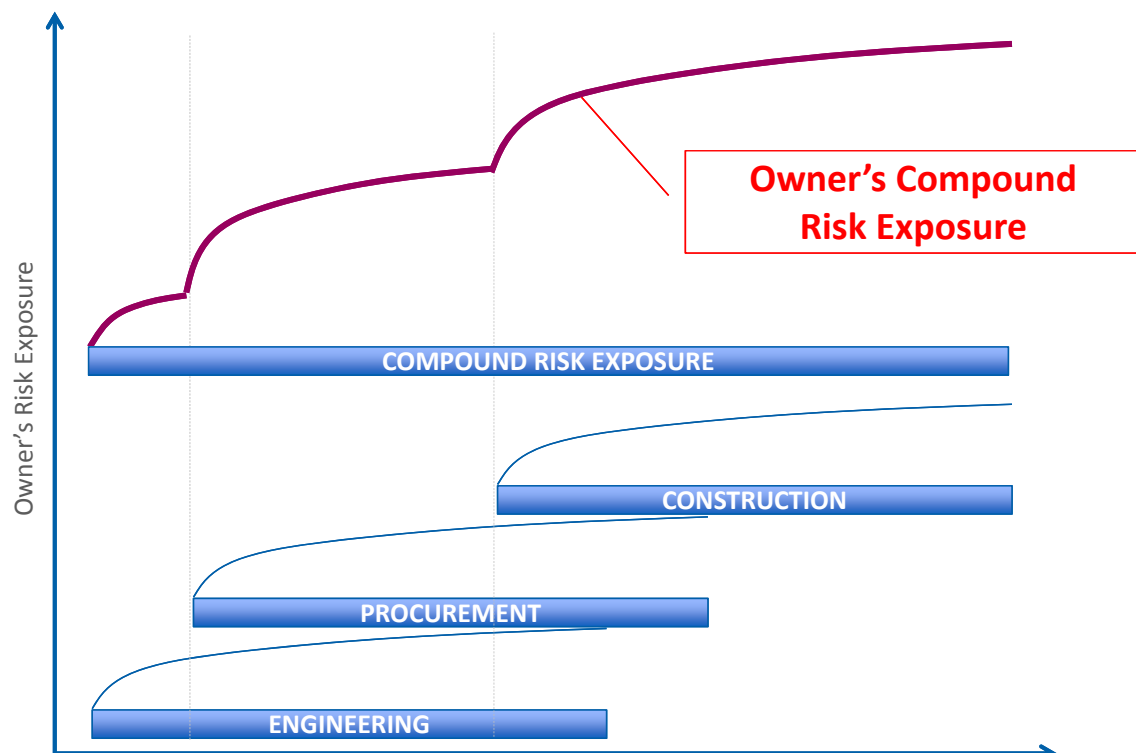
unmitigated engineering risks are a risk to procurement

(e.g; poor management of change creates risk of delayed and inefficient procurement processes)

unmitigated procurement risks are a risk to construction

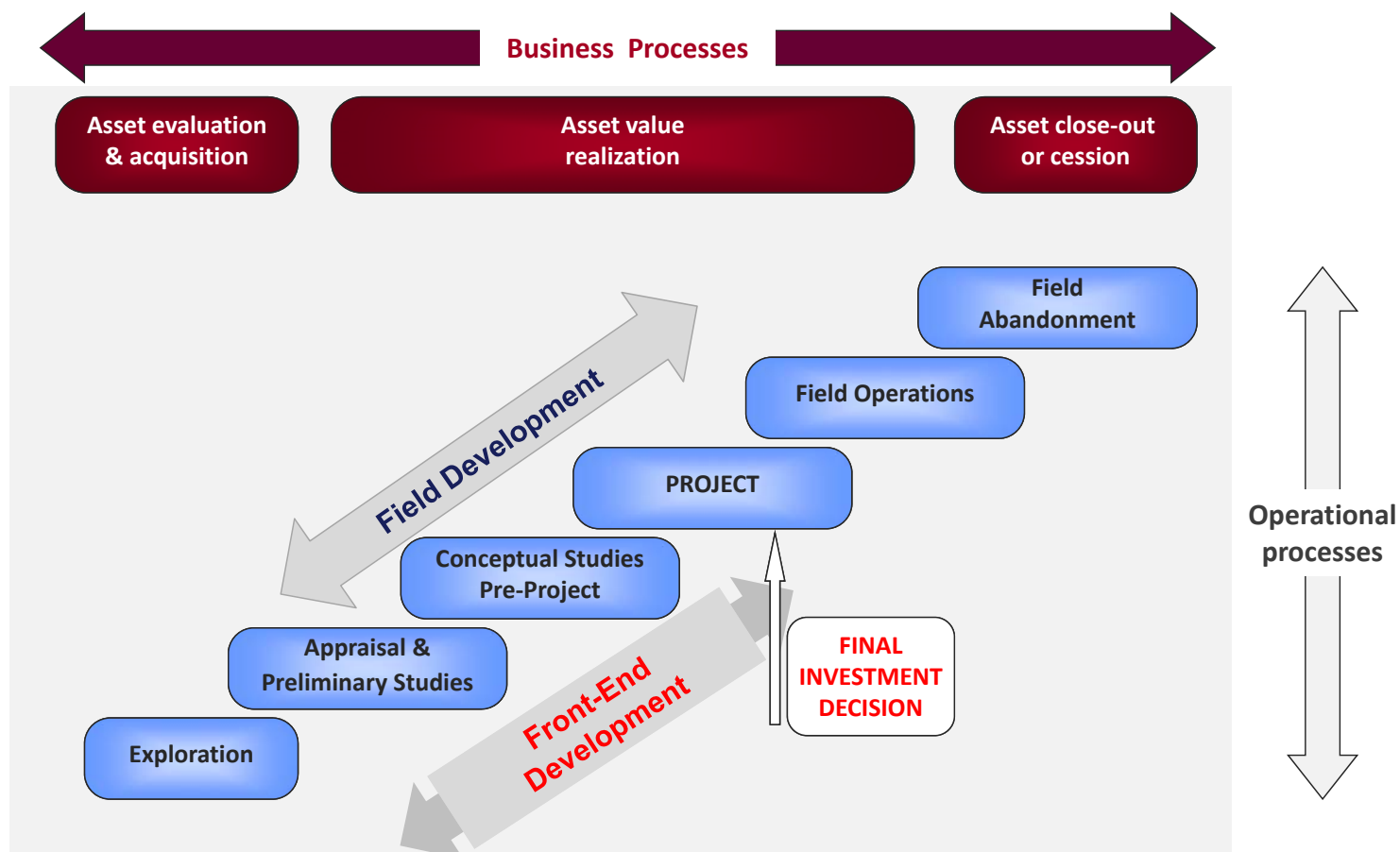
(e.g; poor vendor quality or extended delivery times has an impact on construction productivity)

Risk exposure / compounding exposure during execution



Oil and Gas Field Development Project Definition

E&P assets: business and operational processes



An Oil & Gas Discovery is an Opportunity

- ▶ The process of creating value from such opportunity is *“a structured and comprehensive approach to project identification, planning and execution, where an investment project is developed from a business opportunity into the most profitable operation for the total value chain.”* (Statoil)
- ▶ Optimization of this process has led to the concept of “Stage-Gate Process” in the 80’s.
- ▶ Chevron (with the help of IPA) and Shell were pioneers in the application of Stage-Gate Process in the E&P business in the 90’s.

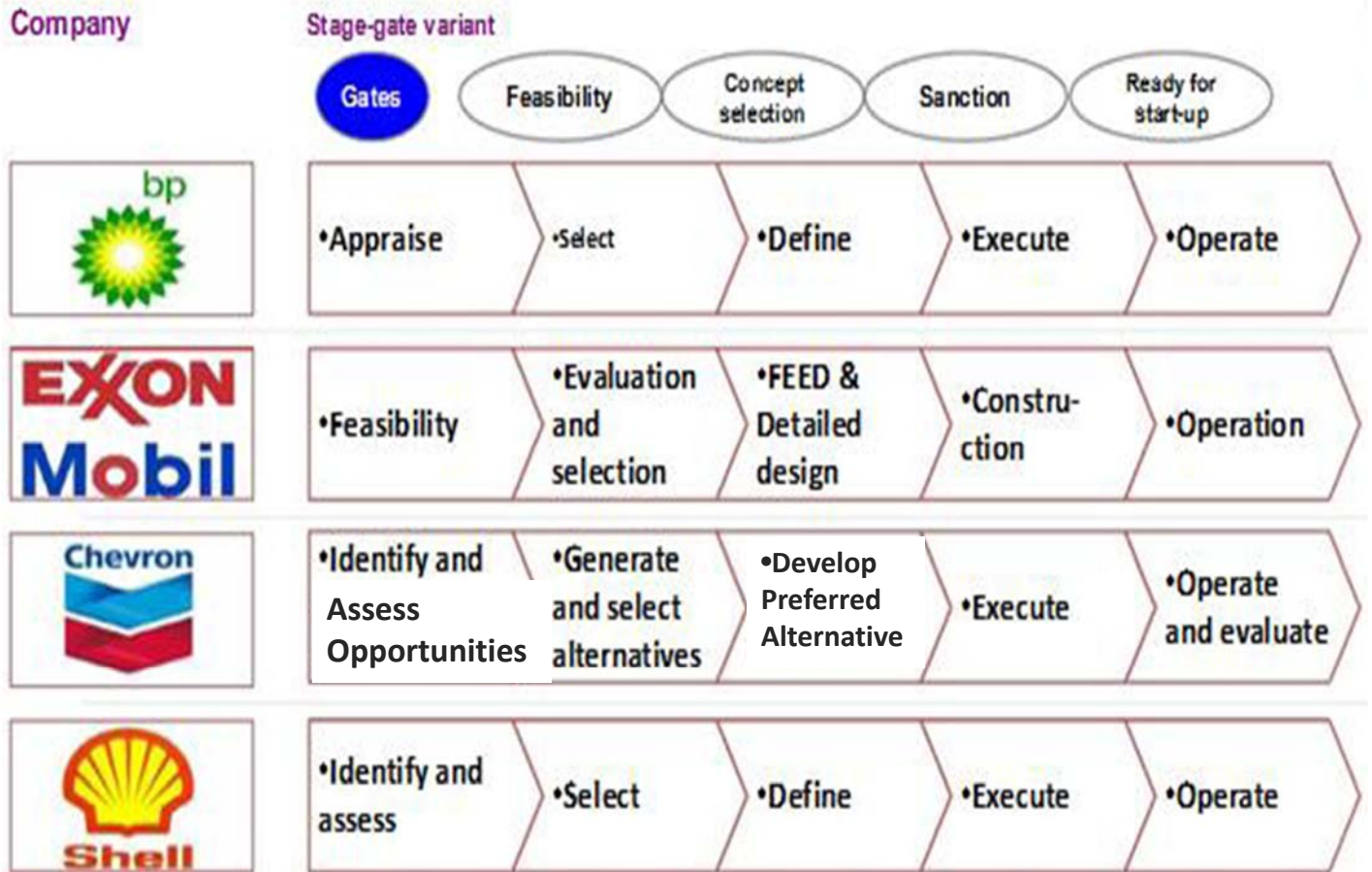
Front-End Loading / foundation for smarter oil and gas field development



- ▶ Traditional project planning seeks to help an operator reach production targets and budgets
- ▶ FEL methodology aligns an operator’s technical and business goals to create a more comprehensive field development plan

By integrating professionals from multiple surface and subsurface disciplines and equipping them with the industry’s latest technology, the FEL approach increases project definition and lowers risk to positively impact total investment costs and return on investment

Stage-gate process: different terminologies



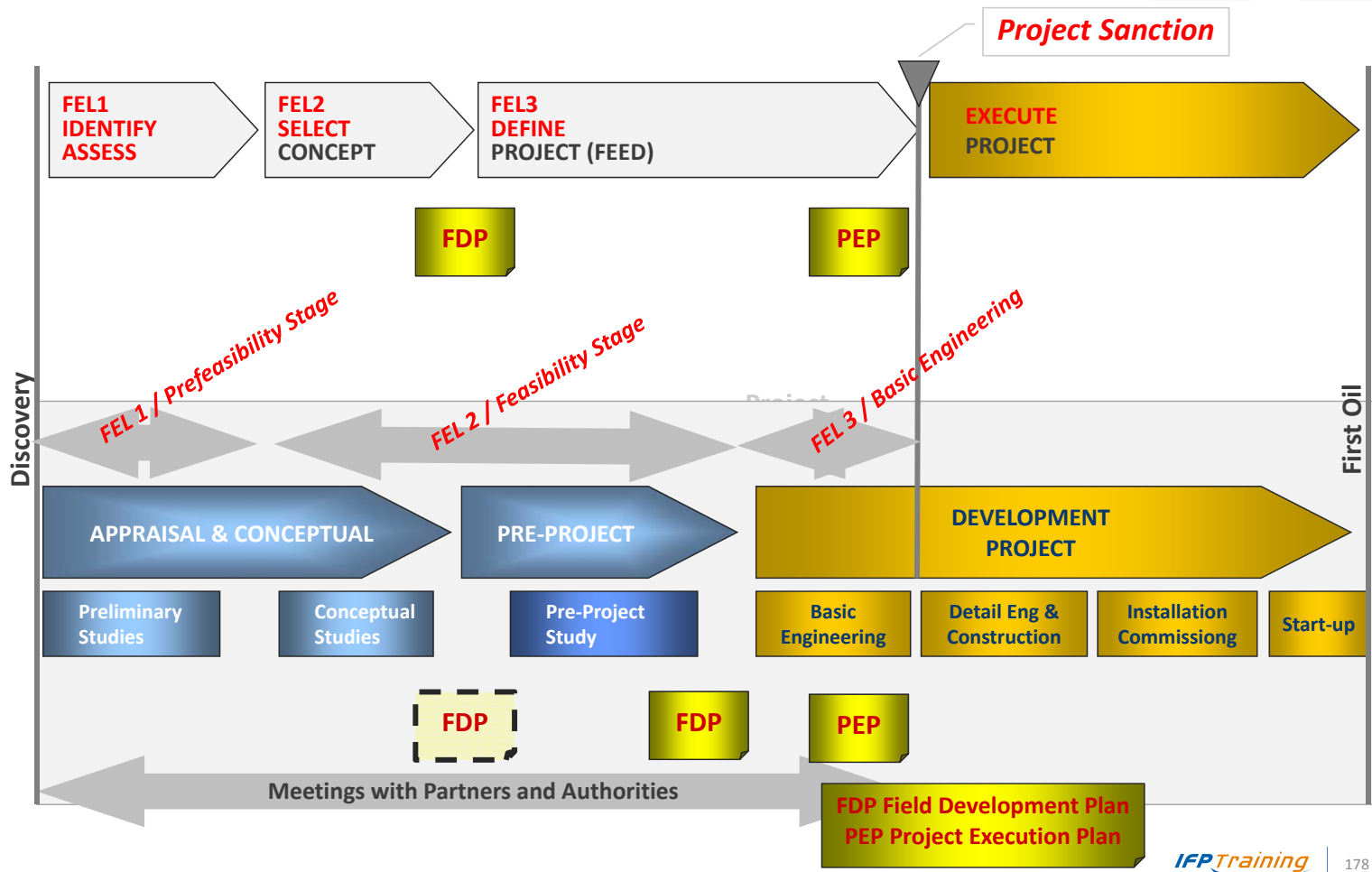
Field development phases / terminology

Various terminologies are used by oil and gas companies:

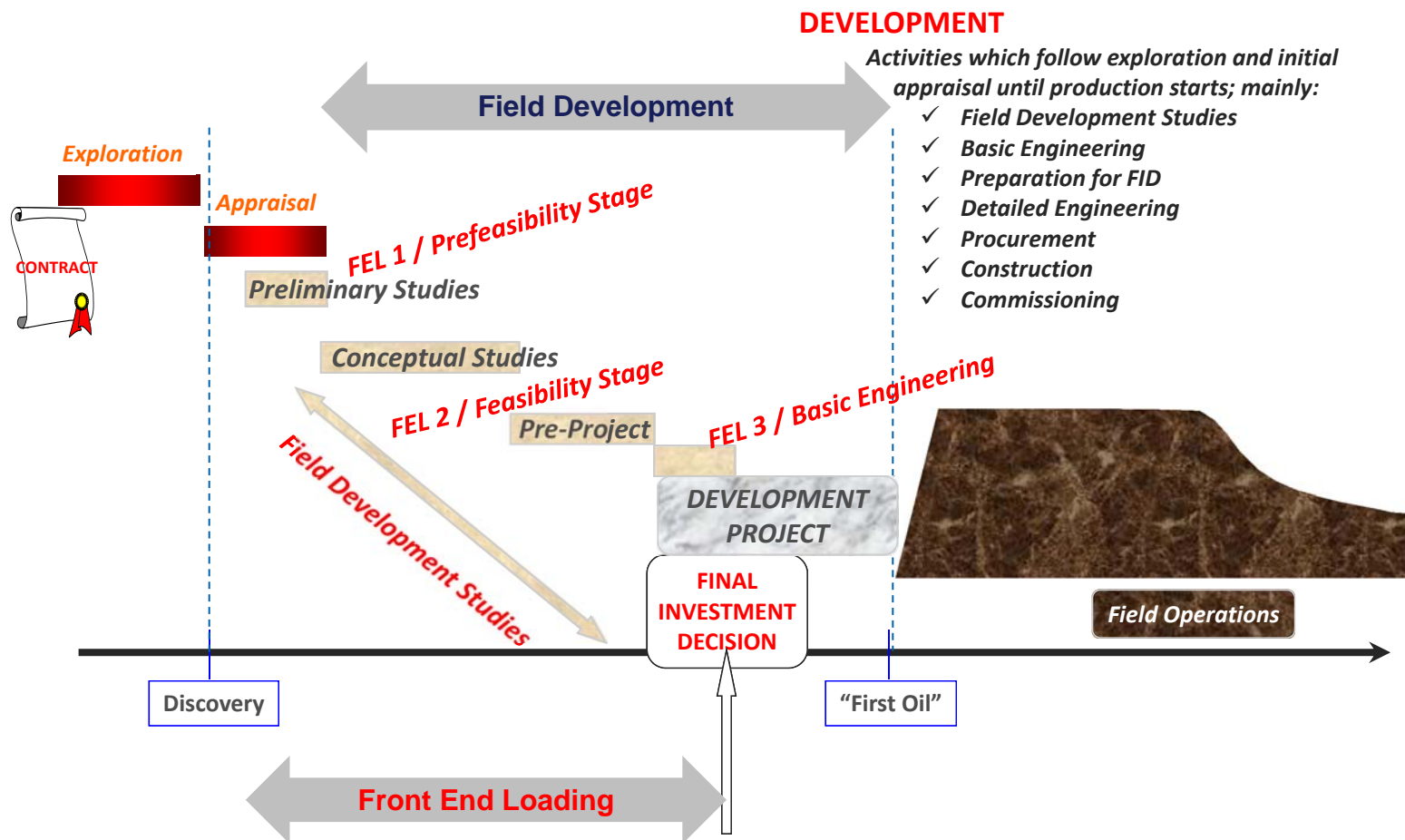
- **FEL1**
 - Preliminary studies or Prefeasibility
 - Visualization
 - Feasibility
 - Identification & Assessment
- **FEL2**
 - Concept Selection and Pre-project
 - Conceptualization
 - Evaluation and selection
 - Selection
- **FEL3**
 - Basic engineering
 - Definition
 - FEED
 - Definition

- **FEL1**
 - Balances (material and energy)
 - Project first organization
- **FEL2**
 - Preliminary design (from material balance) including layout
 - Preliminary schedule and cost
 - Preliminary economic assessment
 - Project organization
- **FEL3**
 - Final schedule and estimates
 - Project execution plan
 - HSE dossier
 - Ready for purchase specifications of major equipment
 - Basic drawings and studies for all disciplines

Typical Front-End Loading processes of E&P projects



Front-End Development in the field development process



Field development validation process



	Appraisal	Pre-Project	Basic engineering	Detailed engineering	Fabrication & construction	Commissioning	Handover to Production
Main documents	Appraisal report Valuation report Feasibility report	Project Development Plan Statement of Requirements Reservoir Mngt Plan Drilling Program	FID Dossier Project Execution Plan Project Procedures Updates of all dossiers issued from pre-Project	Equipment dossiers Materials Construction drawings Commissioning Dossier	As-built Dossier	Commissioning Dossier completed	Close out Report
Project Committees	Geosciences	Risks, Finance, Technical etc	EP Division Executive Committee	Project reviews	Project reviews	Project reviews	Project reviews
Validation (Gate Process)	Approve feasibility study	Approve development plan	FID approval			Operations acceptance	Overall performance
Technical reviews	Yes	Yes	Yes	Yes	Yes	Yes	
Quality reviews	Review	Review	Review, audits	Review, audits	Review, audits	Review, audits	Review, audits
Safety reviews		Hazop, Hazid, Hazan, PRA	Hazop, Hazid, Hazan, PI&D review, QRA	Hazop, Safety dossier update			Safety dossier final issue



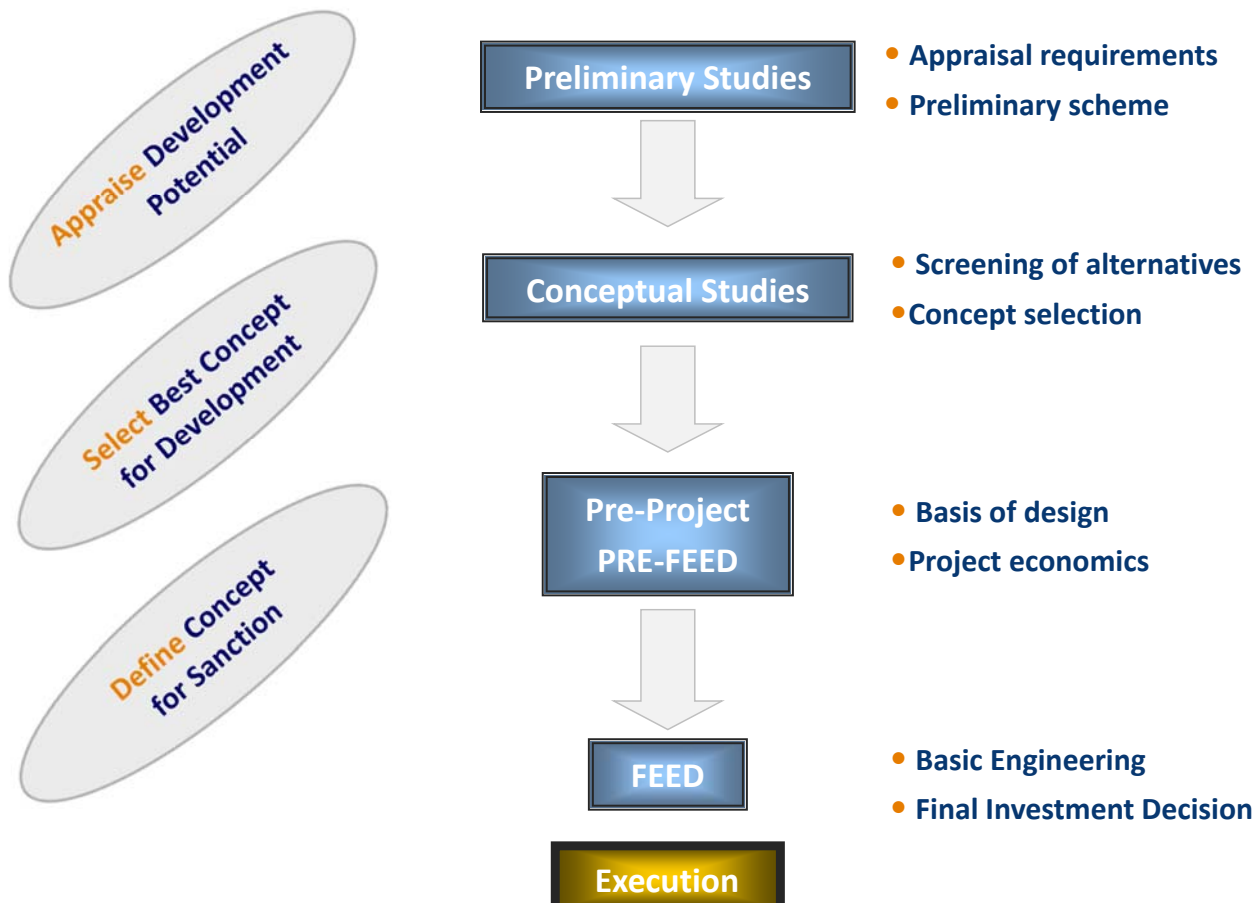
Objectives of an oil and gas field evaluation process

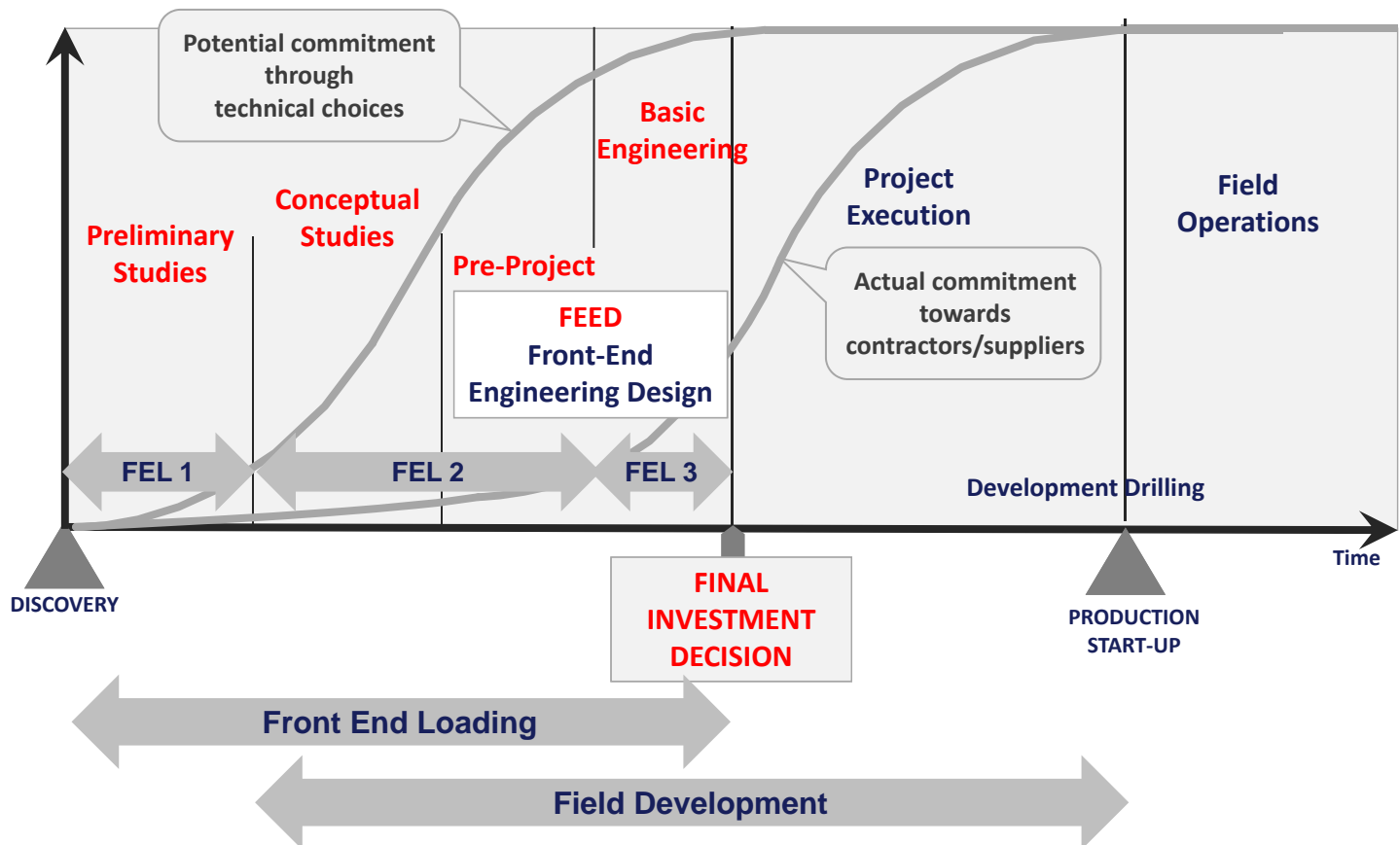
- *define the development scheme for an optimal recovery of hydrocarbons*
- *prepare all required information for Final Investment Decision*

After an initial appraisal just after discovery,
the field evaluation process

- *Preliminary Studies to Appraise Development Potential*
- *Conceptual Studies to Select Best Concept for Development*
- *Pre-project studies to Define Concept for Sanction*

Field development project definition





Basic Engineering and Front-End Engineering Design

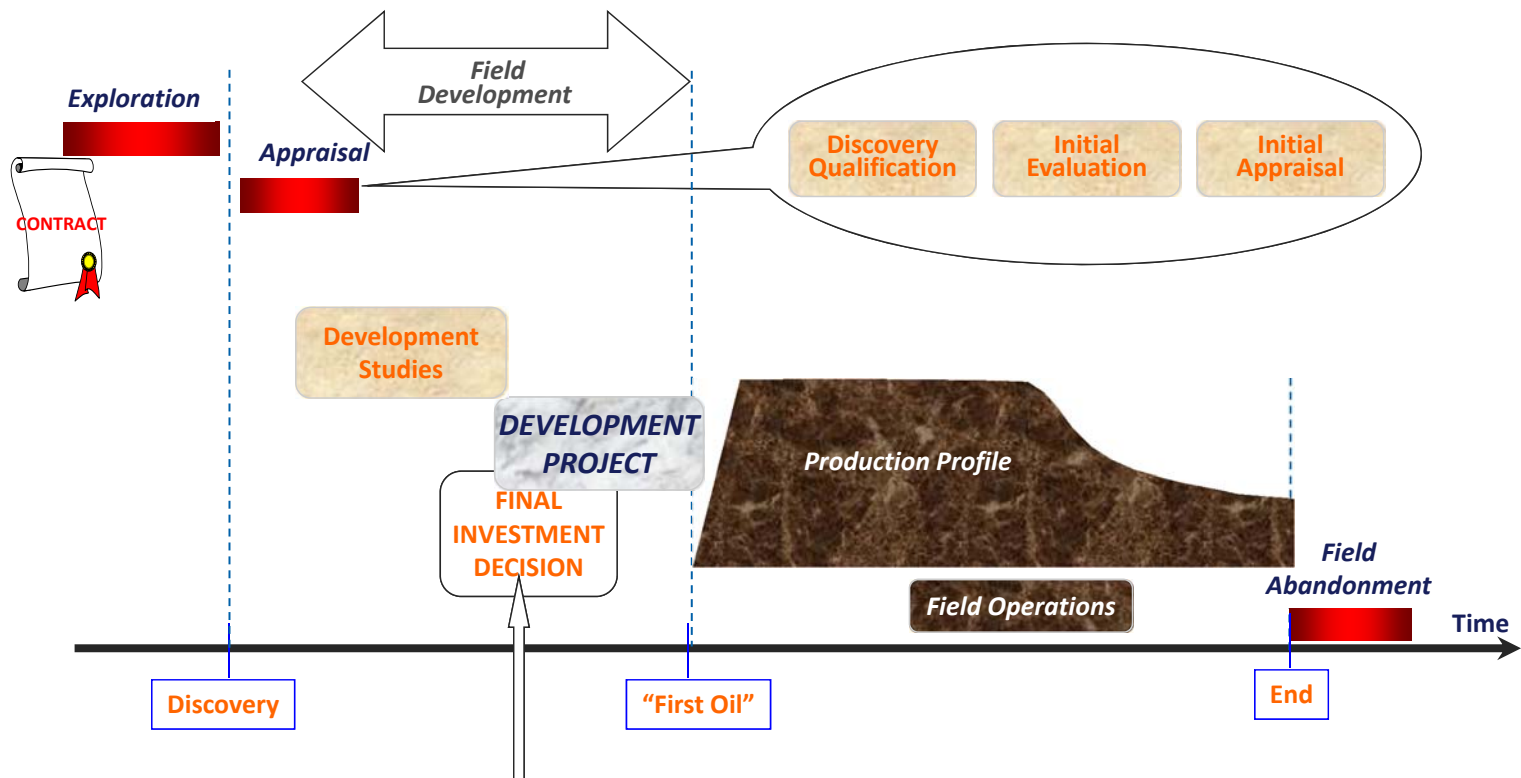
► Basic Engineering

- Set of studies which bring to a successful conclusion various evaluations and allows an engineering company to start the studies of detail for realization.
- That means that after concept selection, a Pre-Project is studied first to define the main lines of the concept, and then Basic Engineering builds a dossier for Calls for Tender.
- Most of the time, the team in charge of the Pre-Project will not be in charge of Basic Engineering.

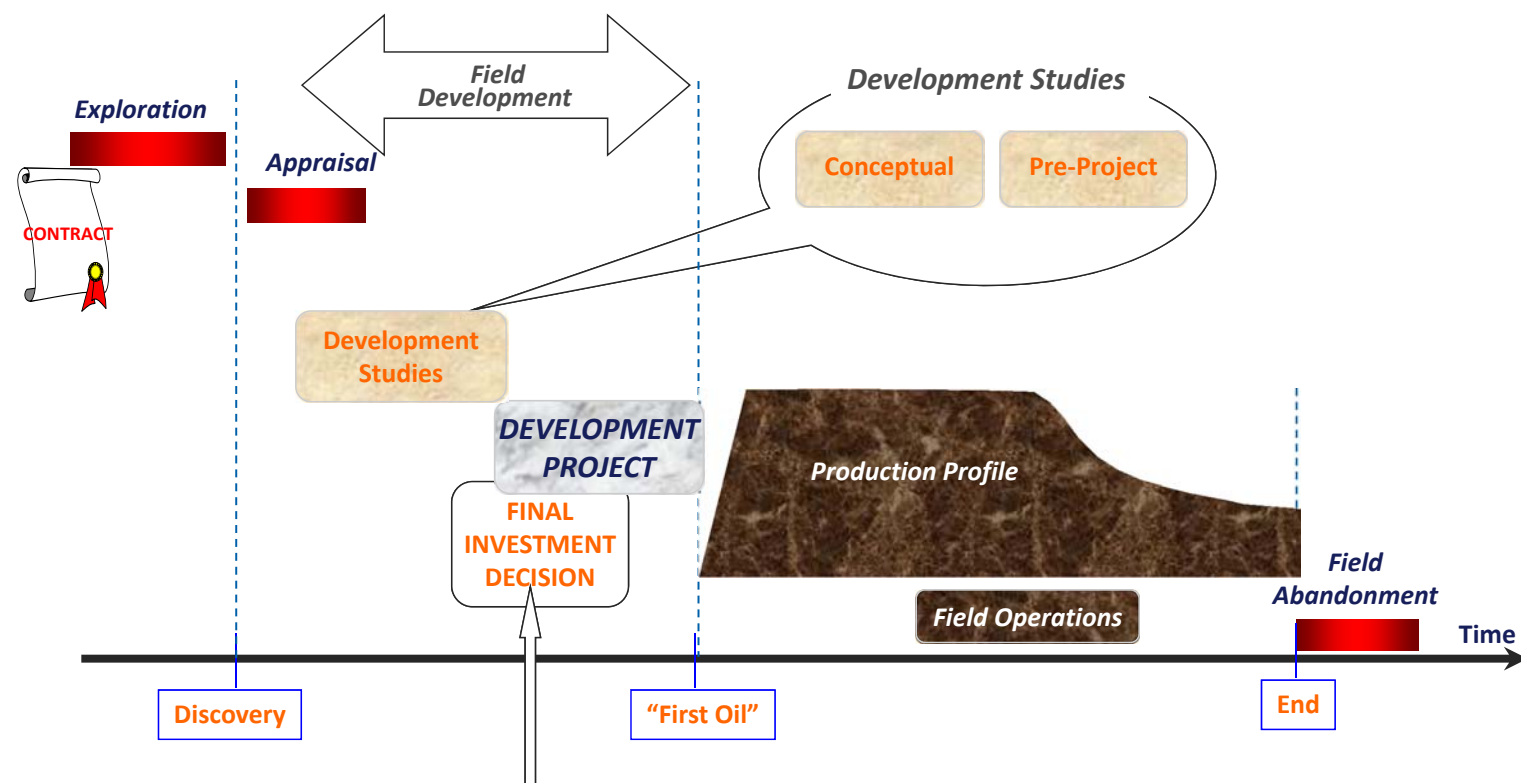
► Front-End Engineering Design

- Set of studies called "Definition" with the same deliverables as Basic Engineering, allowing in particular the Calls for Tender.
- It is carried out after the Concept Selection which is sometimes called "pre-FEED".
- Led by a project team with an engineering contractor.

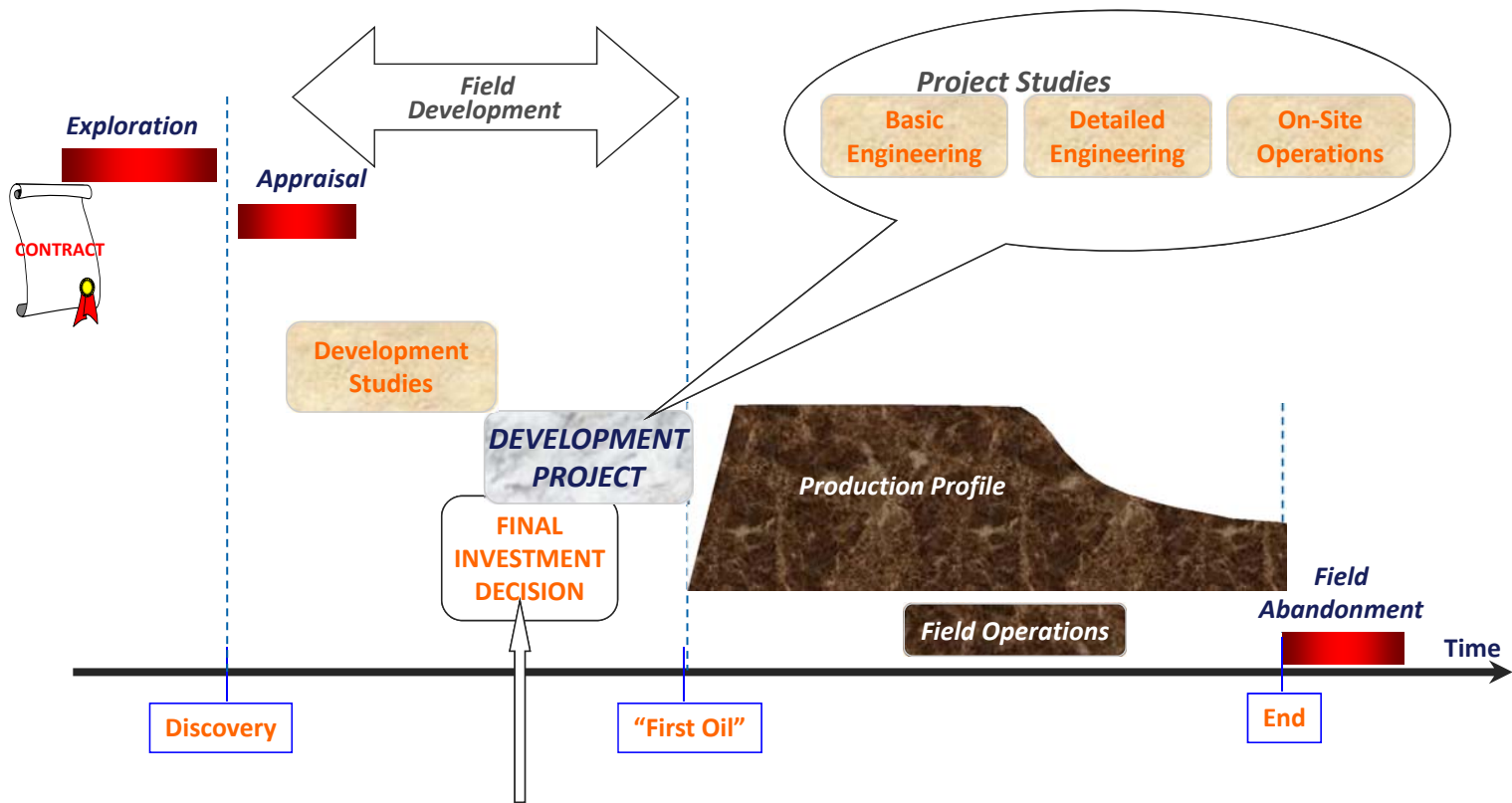
Appraisal phase



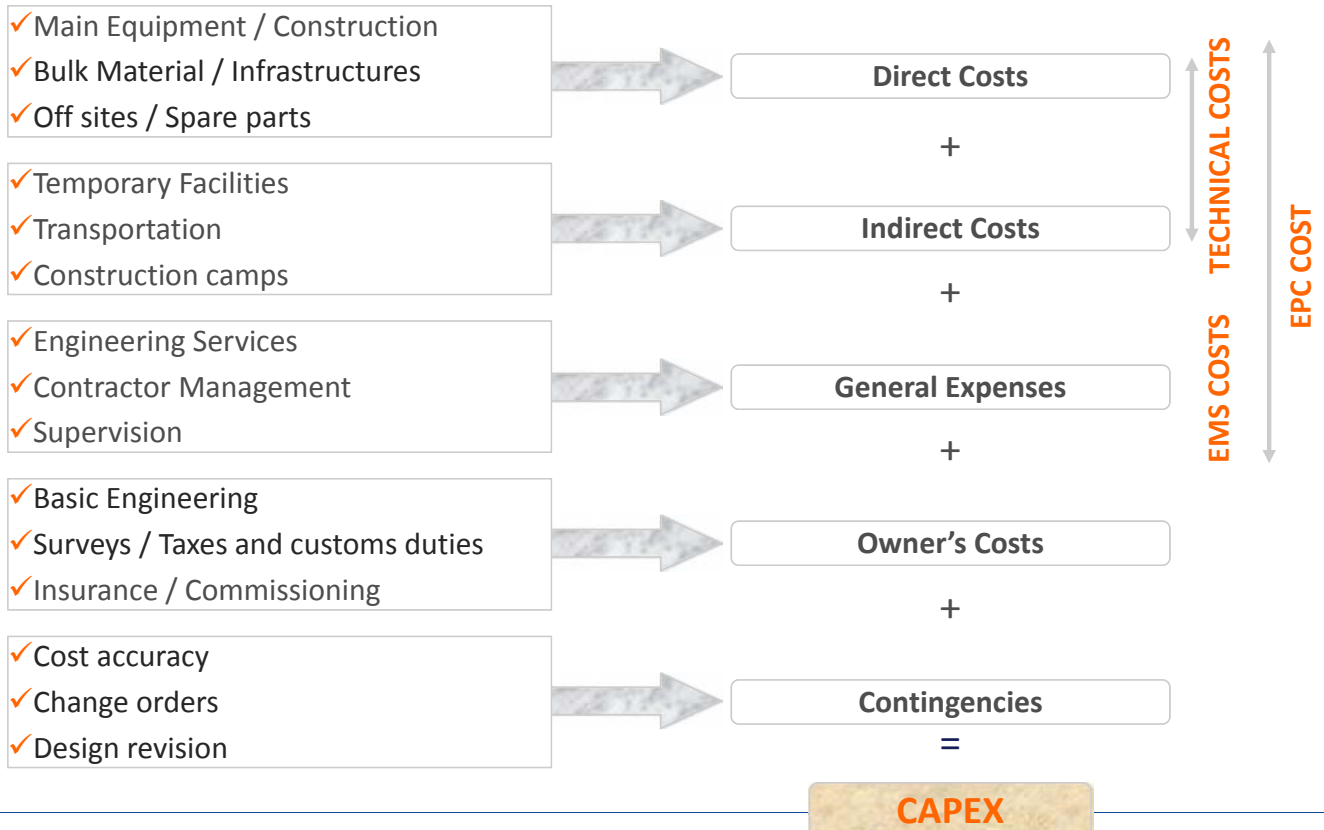
Development studies



Project phase



Cost estimate structure





► Level 0 – Project Master Schedule

Executive summary schedule used for reporting at Project Management level.
This schedule constitutes the Initial Baseline Schedule.
It provides target dates, key milestones and main phases.

► Level 1 – Integrated Project Control Schedule

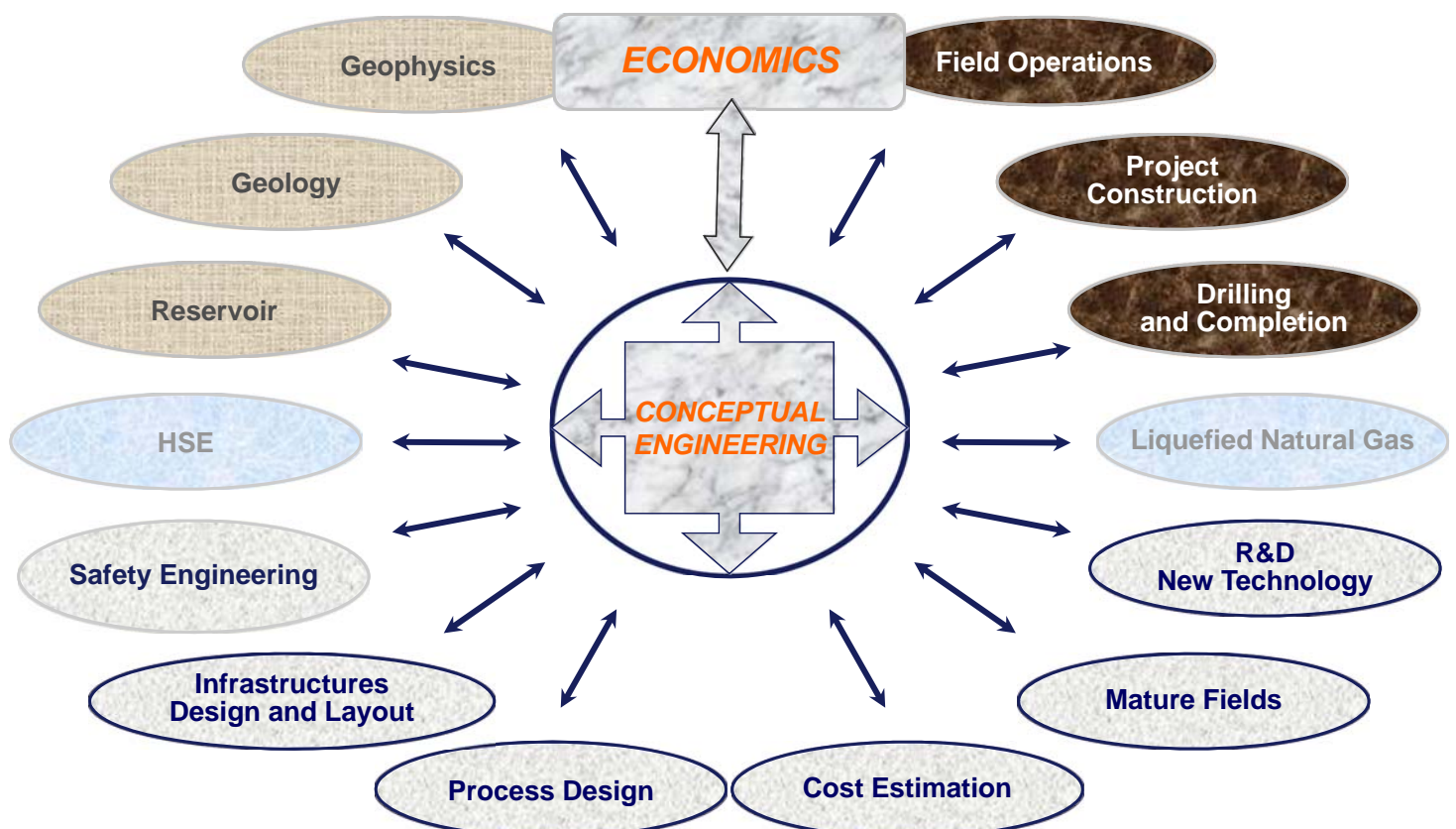
Time-scale diagram including decision process, contracts sequence, work package activities including Long Lead Items, major milestones and overall project critical path.

► Level 2/3 – Contractors Schedules

Schedules covering all activities/tasks of the Contracts and identifying all milestones necessary to control work physical progress.
Procurement of main equipment and fabrication, construction, installation, commissioning shall be shown separately, with a clear highlight of the critical path.

Field development project definition

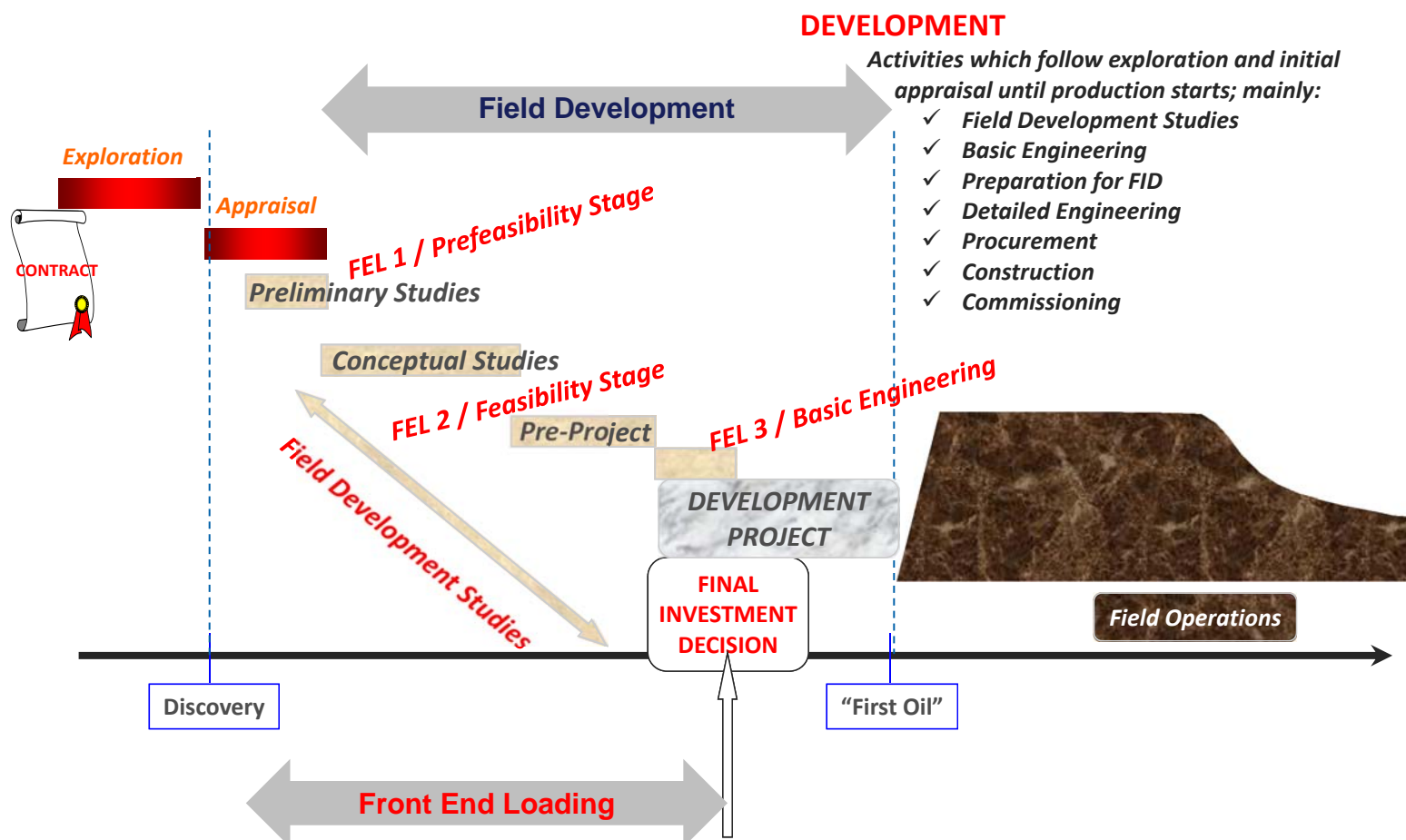
Conceptual engineering: a multidisciplinary approach



FEL 1

Prefeasibility Stage

Front-End Development in the field development process





- ▶ Such studies are intended to help determine whether it is even worth moving to the feasibility phase.
- ▶ Prefeasibility studies are designed to select the base case for developing a project.
- ▶ This may include factors such as potential access points and process methods, and will be used to determine whether or not the project is “feasible”.
- ▶ During this phase, additional reservoir information, drilling and Reservoir Engineering studies may be called for.
- ▶ At this stage, the level of details is very poor given the number of cases to check.

Preliminary studies

- ▶ At preliminary stages, available data linked to reservoir, environment and contract:
 - Asset location
 - Characteristics of fluids
 - Reserves and preliminary process
 - Potential development schemes
 - Export potential
 - Local industry availability
 - Fiscal terms
- ▶ Only global information is used to determine the production schemes.
- ▶ Process calculations, sizing of equipment, layout and other general arrangement drawings are not yet done.
- ▶ Any cost calculation or schedule estimation are highly inaccurate and give just an order of magnitude.

► **According to the « Stage-Gate Process », moving from pre-feasibility phase to feasibility phase will need a dossier of pre-feasibility which will indicate:**

- list and description of all possible field development schemes
- reason for abandoning some of the schemes
- selected schemes
- technical assumptions
- economics
- preliminary schedules
- quality control reports, etc.

At the end of prefeasibility studies, only a few schemes are selected.

The relevant Committee validates, then decides to proceed to Feasibility Phase.

► **Selecting the base case for developing a field**

- From all the schemes, one will be retained as base case
- It will be the reference
- It is the scheme which
 - has the greatest number of advantages
 - Includes some innovation but not too much
 - may be realized in a reasonable period
 - has the best economics (with all uncertainties)
 - Is a good compromise between « must have » and « nice to have »
 - etc.



► Basis of study

- Patrimonial contract, reservoir (exploration, discovery, flow rate, oil analysis), location, environment, oil or gas export

► Constraints

- HSE, applicable laws, rules and standards

► Specific requirements

- Specific requirements from State, stakeholders, development philosophy – fast track, conventional development, etc.

► Technical feasibility

- During prefeasibility studies, due to the poor level of detail reached, technical feasibility is not really checked

Preliminary schedule and cost estimates

► In preliminary phases, available information lacks accuracy and only a **Level 0 – Project Master Schedule is developed**

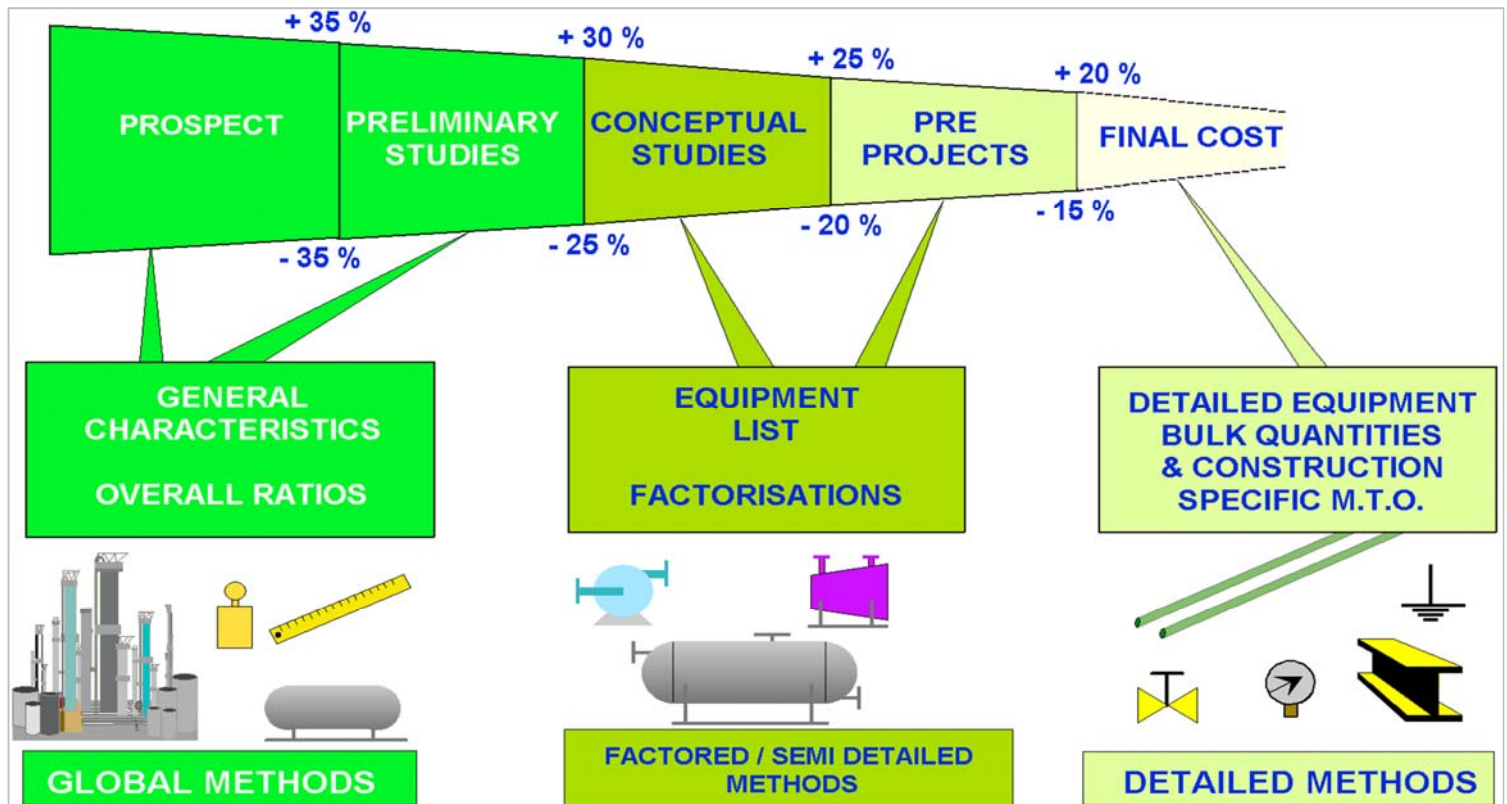
Executive summary schedule used for reporting at Project Management level.

This schedule constitutes the Initial Baseline Schedule.

It provides target dates, key milestones and main phases.

► Cost estimate

- At preliminary stage, available information:
 - Location, Reserves, Potential production flowrate, Oil quality
 - Idea on the process (material balance, energy balance (?)), Potential clients, etc.
- At preliminary stage, non available information:
 - Process data, Equipment data, Materials selection, Size of facilities
 - Pipeline characteristics, Support characteristics, etc.
- It is impossible to make a cost estimate based on quantities and only comparison with existing projects may give an idea of the costs.
- The only way to estimate costs is the Global Method.



Key points on FEL 1 – Prefeasibility Stage



► Objectives of preliminary studies

- To determine if moving to the feasibility phase is acceptable
- To request additional reservoir information
- To start traceability by going from one step to another through reviews

► Preliminary scheme and technical feasibility

- Basis of study and constraints

► Preliminary schedule and cost estimates

- Reliable order of magnitude

► Economics

- Rough estimates of project's economics and uncertainties

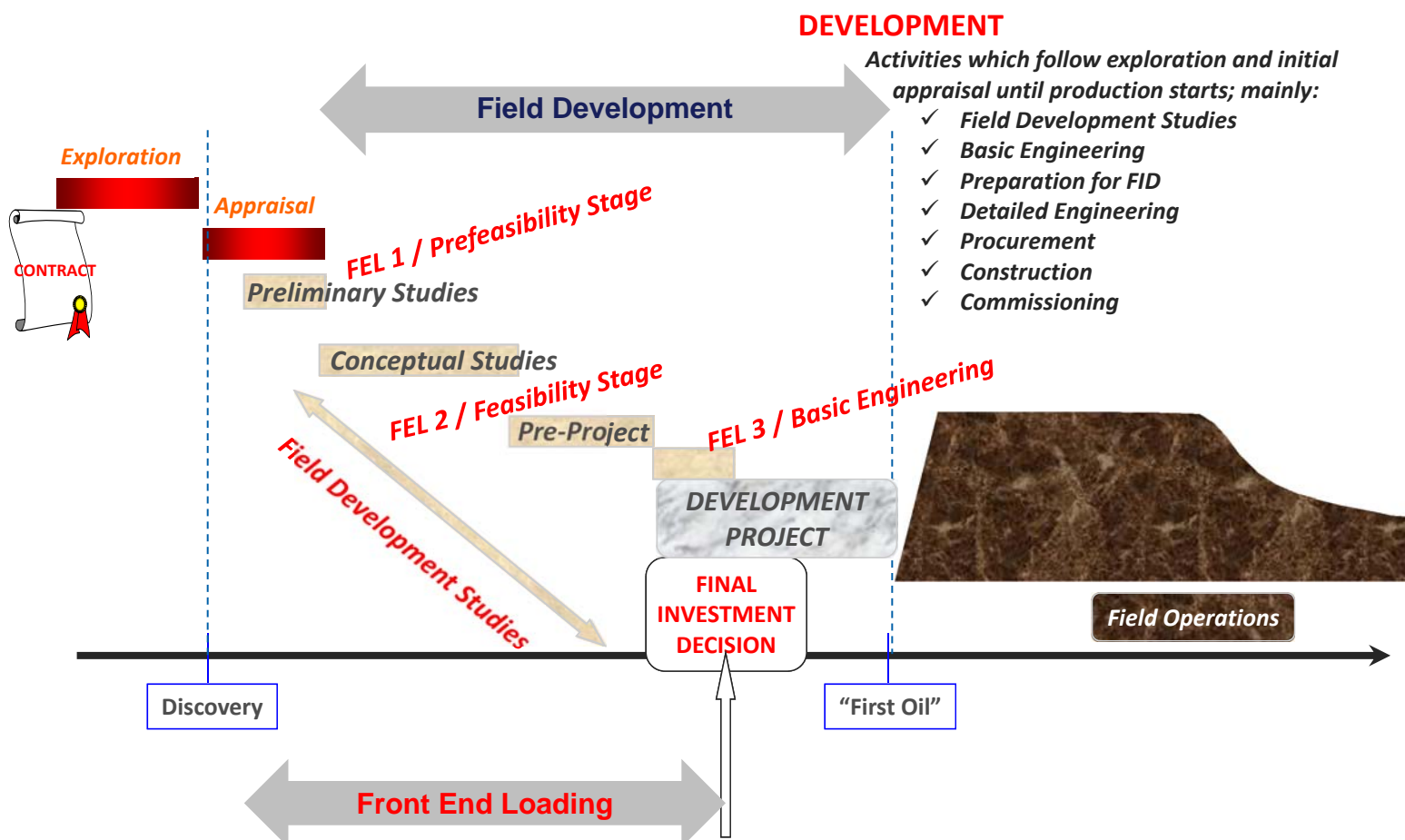
► Safety, environment and stakeholders issues

- Preliminary assessment

FEL 2

Feasibility Stage

Front-End Development in the field development process





- ▶ Conceptual studies are made to study in detail the short listed options identified in the prefeasibility phase:
 - evaluate whether the project is technically possible
 - determine whether the project will be profitable
 - identify the remaining reservoir uncertainties and propose a program to reduce them (complementary appraisal or specific data acquisition)
 - compare several development scenarios
 - recommend the best concept
 - confirm the economic viability of the recommended scenario
 - evaluate cost and duration of pre-project/FEED phase

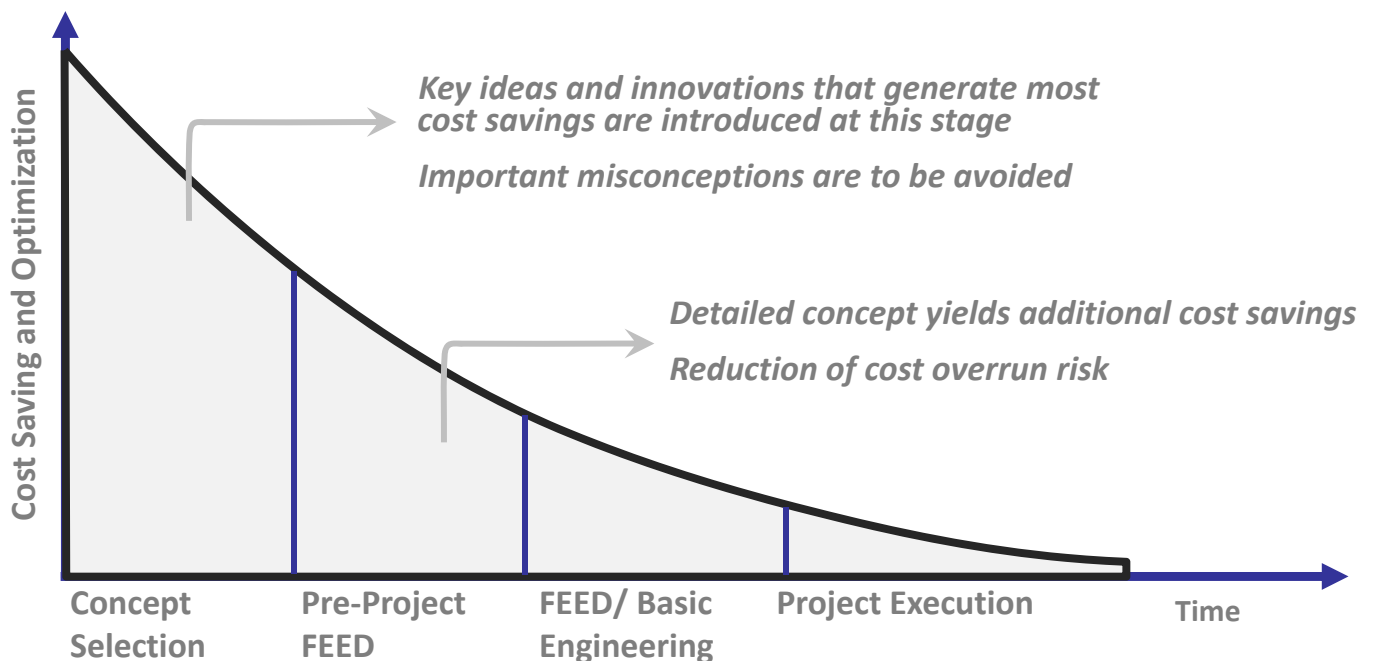
Screening of alternatives and confirmation of feasibility

- ▶ **Once the base case is known**
 - Review and organize alternative solutions from the most probable to the least probable.
 - All alternatives are evaluated (more or less roughly) and a large number are abandoned.
 - For traceability purpose, each alternative has its follow-up system describing the content of the scheme, the costs and schedule aspects, the organizational and contractual approach and any other aspects that have been considered to decide to retain it or not.
 - In case of abandon, reasons are clearly identified, per subject.
 - For the alternative that is finally selected, feasibility must be checked more closely.
- ▶ **Information collected for**
 - BoD (Basis of Design) or SOR (Statement of Requirements)
 - PEP (Project Execution Plan) / PMP (Project Management Plan)
 - FDP (Field Development Plan)

Cost savings will result from a balance between “Must Have” and “Nice-to-Have”

- ▶ **At preliminary phases, costs are not yet defined but the choices made during that phase will impact:**
 - Capital expenditures
 - Phased or full field development / Equipment, Materials
 - Structures (concrete, steel, floating, etc.) / Technologies, etc.
 - Operating expenses
 - Selected process / Export solutions / Resources, etc.
 - Decommissioning costs
- ▶ **Must-Have:** requirements that absolutely have to be delivered for the project to be considered successful (critical, base, or minimum requirements).
- ▶ **Nice-to-Have:** requirements that are considered desired or even important but unnecessary for the overall completion of the project (optional, non-critical or auxiliary requirements)

Front-End Development and costs savings



The most important is to have only one list to compare all schemes

► Architecture, Reservoir and Drilling

- Production profile
- Wells feasibility
- Reliability, Availability, Maintainability
- Costs (wells and facilities)
- Planning
- Risks assessment

► Phasing option

- Phased approach
- Full Field approach

► Facilities

- One plant or several autonomous satellites
- One or several platform(s) etc.
- Production concept

► Contractual strategy

Concept selection is generally carried out by an entity called "Development Planning", or "Petroleum Engineering", or "Opportunity Development"

Pre-FEED important deliverables



► BOD (Basis of design) or SOR (Statements of Requirements)

► PEP (Project Execution Plan)

- strategy for managing the project
- policies, procedures and priorities

► PMP (Project Management Plan)

- planning document, capturing the entire project end-to-end
- all project phases, from initiation through planning, execution and closure

► FDP (Field Development Plan)

- details the best technical solution
- HSE, environmental impact, geophysics, geology, reservoir, drilling, well design and completion, production engineering, surface facilities, infrastructure design and construction, economics and risk assessment

- ▶ It summarizes the field development plan of the pre-project study.
- ▶ It formalizes the "scope of work" of the Project Team in charge of implementing it.
- ▶ It must be a clear and complete document which will be permanently referred to, from its issue at the end of the pre-project, until the completion of the Project.
- ▶ Its main purpose is to ensure that all parties – the designer, the project manager, and the future operator – have understood and agreed upon the fundamental choices pertaining to the development scheme.

Project Execution Plan (PEP)

- Project definition and brief
- Layout plans, elevations and sections
- Roles, responsibilities and authorities
- Monitoring and reporting strategies
- Cost plan and management
- Risk analysis
- Program (planning and scheduling)
- Contracting strategy
- Procurement strategy
- Administrative procedures
- Quality assurance strategy
- HSE studies (HAZID, HAZOP, HAZAN)
- Environmental policy
- Document control systems
- Document distribution matrix
- Commissioning strategy
- Migration strategy
- Operational strategy
- Post-occupation evaluation strategy
- Equipment requirements
- Unusual or long-lead items
- Business change
- Staff training requirements
- Potential call for tenders

Project Management Plan (PMP)

- **Overview:** why the project is being conducted and its primary objectives
- **Scope:** business needs, requirements, deliverables, constraints and work breakdown structure
- **Schedule:** activities schedule and project milestones
- **Costs:** project budget and funding
- **Quality:** assessment and control
- **Team:** roles and responsibilities
- **Communication:** channels and reporting approach
- **Risks:** risk index, methods to identify and evaluate risks, risk mitigation and contingency planning
- **Procurement:** required procurements and purchase processes
- **Closure:** closure approach, including the deliverables hands-off protocol
- **Changes:** procedures used to track changes in the project
- **Baselines:** scope, schedule and budget baselines

Field Development Plan (FDP)

- ▶ A Field Development Plan is a support document for development and production authorizations which should provide:
 - a brief description of the technical information on which the development is based
 - a summary of the operator's vision for the field development:
 - number of wells to be drilled to reach production objectives
 - recovery techniques to be used to extract oil and gas from the reservoir
 - type and cost of installations such as platforms in the offshore environment (tides, storms, waves, winds, corrosion, ...),
 - separation and treatment systems for gas and fluids
 - environmental issues
- ▶ The project manager must also have the economist present the economic results of the investment profitability study

Key points on FEL 2 – Feasibility Stage

Conceptual study report (1/2)



□ **Basis of Design**

- ✓ Geographical, geotechnical and environmental data.
- ✓ Petroleum, industrial and economic environment.
- ✓ Seismic, exploration and appraisal wells data (logs, PVT, production tests, etc.)
- ✓ Rules and regulations from Company, international and local authorities.

□ **Subsurface**

- ✓ Geological and geophysical evaluation.
- ✓ Reservoir: depletion strategy, well count, recovery factor, reserves, etc.
- ✓ Possible development schemes.
- ✓ Screening of possible development schemes, including innovative solutions.
- ✓ Selection of 3 to 4 schemes to be evaluated and compared.

Key points on FEL 2 – Feasibility Stage

Conceptual study report (2/2)



□ **Technical Description of Selected Development Concepts**

- ✓ Drilling and completion. Field layout.
- ✓ Gathering system, processing units, utilities and export system.
- ✓ Sustainable development and HSE. Operating philosophy.
- ✓ Project execution, planning and costs.
- ✓ Duration of field production, CAPEX and OPEX estimates.

□ **Comparison of Concepts**

- ✓ Recovery, operability, sustainability, risks, planning, economics, etc.
- ✓ Recommended development concept.
- ✓ Risks and uncertainties.
- ✓ Required data acquisition and scope for further studies.

Key points on FEL 2 – Feasibility Stage

Pre-Project study report (1/2)



❑ **Basis of Design**

- ✓ Update of Conceptual Study Report (results of new surveys, wells, etc.)

❑ **Subsurface Evaluation**

- ✓ Update of the subsurface section of the Conceptual Study Report.

❑ **Well Engineering**

- ✓ Drilling & completion. Well monitoring and data acquisition. Well interventions.

❑ **Process and Flow Assurance**

- ✓ Definition and sizing of gathering networks, processing facilities, export system and utilities.
- ✓ Process Flow Diagrams (PFDs) and Piping & Instrumentation Diagrams (PIDs).
- ✓ Main production parameters, chemicals,...

❑ **Field Layout and Facilities, Sizing and Weight Estimates**

- ✓ Well centers, pipelines network, processing and utilities units, living quarters, offsite facilities.

Key points on FEL 2 – Feasibility Stage

Pre-Project study report (2/2)



❑ **Operating Philosophy**

- ✓ Operability, maintainability, equipment redundancy, plant availability factor.
- ✓ Manning. Operations support facilities. Consumables. OPEX.

❑ **Sustainable Development**

❑ **Safety and Environment**

- ✓ Safety concept. Environmental impact assessment.

❑ **Project Execution Plan**

- ✓ Project planning and costs. Contractual strategy.
- ✓ Local content. Risks and uncertainties.

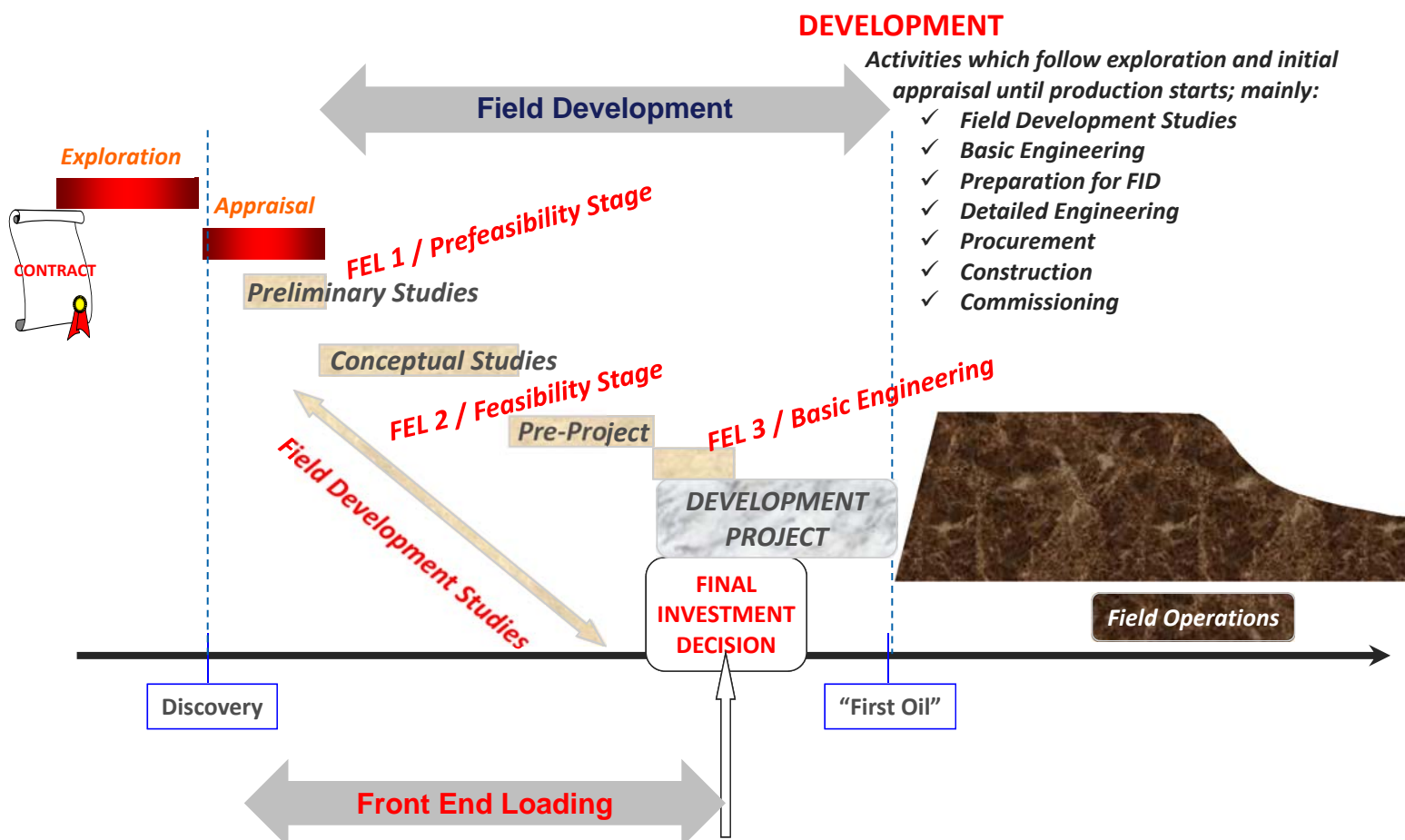
❑ **Preliminary Plan for Site Abandonment**

❑ **Remaining Potential and Future Development**

FEL 3

Basic Engineering

Front-End Development in the field development process



- ▶ **Basic Engineering develops the concept selected at the end of the conceptual studies and studied in details during the pre-project phase in order to:**
 - provide enough details to enable contractors to prepare offers for the execution
 - minimize risks of changes during project execution
 - sanction the project on a sound basis
 - prepare technical service contracts for the execution phase
- ▶ **Basic Engineering Package includes:**
 - Process Descriptions, Heat and Material Balance, Process Flow Diagrams (PFDs)
 - Major Equipment or Equipment Lists and Specifications
 - Information for special equipment
 - Cause and Effect matrices
 - Operations and Start-Up manuals or instructions
 - Recommended Plot Plan
- ▶ **Process Licensors provide specific Process Packages or equipment**

Basic Engineering: disciplines and content

Disciplines

- ▶ Process
- ▶ Thermal
- ▶ Equipment and tanks
- ▶ Corrosion / Piping
- ▶ Civil / Buildings
- ▶ Infrastructure
- ▶ Electrical
- ▶ Controls and Instrumentation

Content

- ▶ Safety requirements
- ▶ Design and construction standards and specifications
- ▶ Construction specific requirements
- ▶ Piping & Instrumentation Diagrams (PIDs)
- ▶ Interfaces requirements
- ▶ Temporary construction facilities requirements
- ▶ Pre-commissioning and commissioning requirements

► Project Scope

Scope management plan

- how the detailed scope statement is to be delivered
- relationships between various phases
- process for establishing the work breakdown
- how the work breakdown will be updated and approved
- acceptance criteria of completed deliverables
- how requests for changes to the detailed scope are to be processed

► Project integration

Integration management plan

- Unification, consolidation, articulation of actions that are crucial to project completion
- Making choices and tradeoffs among competing objectives and alternatives
- Making decisions about where to concentrate resources and effort

Project organization

The objective is to organize the Supervision team for an effective and efficient project execution, from conceptual stage to facilities start-up

- Identify all parties involved in Project Performance
- Confirm their roles, responsibilities, Scope Of Work, location
- Establish the Project Execution Plan
- Develop the Organization Chart
- Select and mobilize Company personnel
- Select and implement management policies and procedures

► **Company's Project Management Team is located at the center of gravity of the activities: main contractor home office, and then the construction site.**

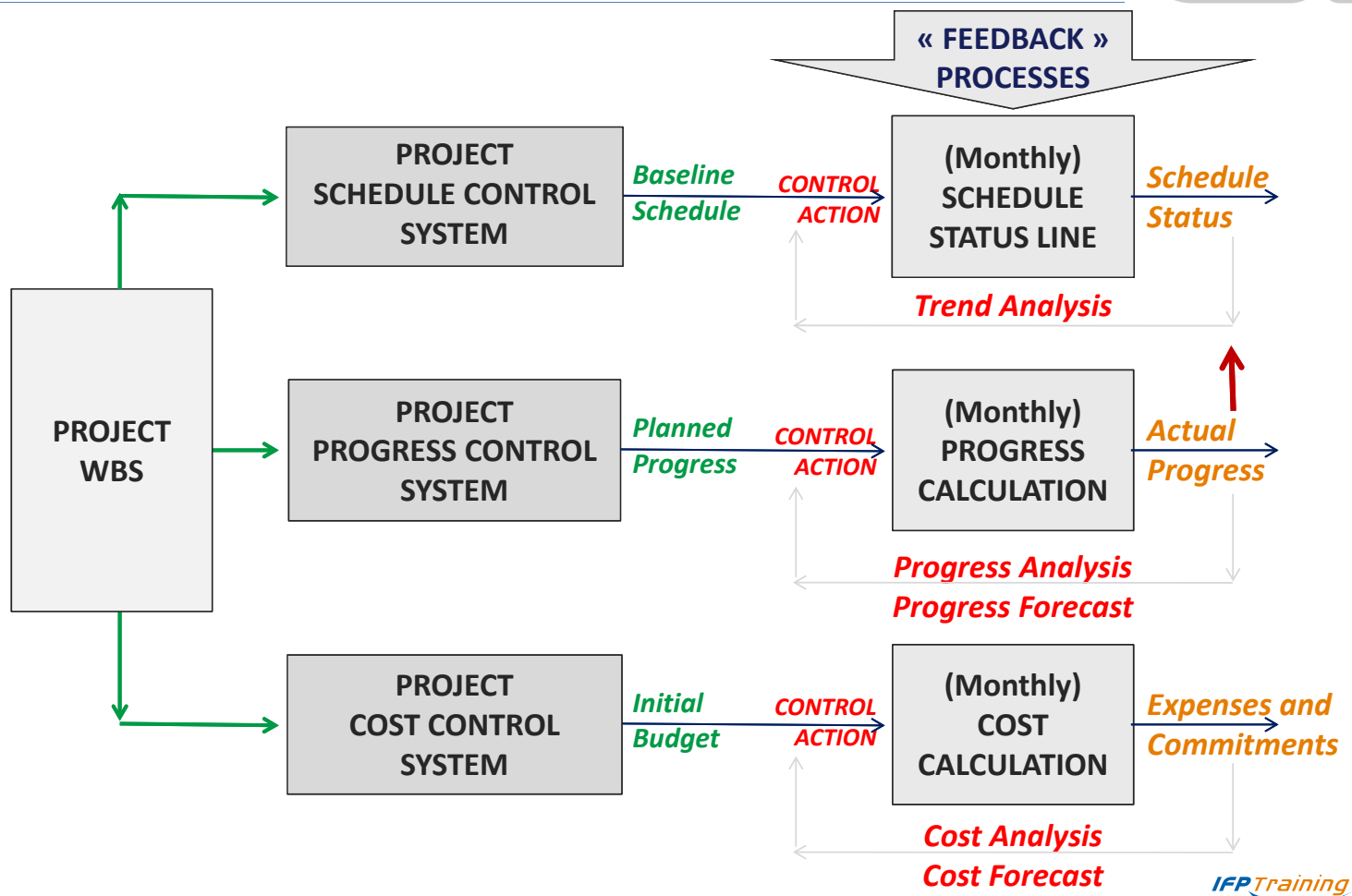
► **Work Package Managers and their teams are located at the relevant Work Package Contractor home office, and then possibly at site.**

Breakdown Structures are central to Project Management

- **WBS** (Work Breakdown Structure)
used to build the schedule, to decompose the project scope, to improve estimating, to control the project execution and to verify project completion
- **OBS** (Organization Breakdown Structure)
used to communicate through organization charts how those in charge of delivering the project will be organized as a Project Team, to check resources, and to calculate mob/demob plans
- **CBS** (Cost Breakdown structure)
classification of project costs per cost center and per cost type
used for budgets, cost planning, cost control, and cost reduction measures
- **CoBS** (Contract Breakdown Structure)
arrangement of contractors, subcontractors, suppliers etc., to show the overall supply chain feeding goods and services into the project

Breakdown Structures are central to Project Management

- **RBS** (Resource Breakdown Structure)
hierarchy of all human resources in the various functions used to facilitate work planning and control
- **PBS** (Product Breakdown Structure)
exhaustive, hierarchical tree structure of components that make up a product
- **BOM** (Bill of Materials)
Decomposition of each tangible element of the project into its components that are to be purchased
- **RiBS** (Risk Breakdown Structure)
depiction of identified project risks arranged by category and source so that total risk exposure can be understood and managed



Company's Project Execution Plan

Document is issued during pre-project

- Project Context and Description
 - Stakeholders
 - Development Scheme
 - Technical Referential
- Project Objectives
 - Budget and Planning (lifecycle)
 - HSE and Quality
 - Sustainable Development
 - Local Content
- Project Implementation
 - Organization
 - Contractual Strategy
 - Risk Management
 - HSE Management
 - Insurance and Financing
 - Quality Management

► HSE

- Minimize impact and maintain risks at an acceptable level
- Meet HSE requirements during execution, and for the whole lifetime of the project
- Local Content: comply with regulations and objectives, contribute to local development

► Technical objectives

- Comply with all technical requirements, including audits and review, performance test
- Implement applicable QA policy and QC system, achieve all tests, and 3rd party control
- Ensure all technical interfaces requirements are satisfied

► Schedule

- Comply with the Project schedule and limit effect of slippage and disruption
- Achieve timely provisional acceptance

► Budget

- Complete the Project within the approved budget
- Control all cost overruns and changes from initial objectives

► Stakeholders

- Identify and confirm roles and objectives of all entities
- Promote effective and open communication



CONTENT

► General

- Project Background and Description
- Project Objectives
- Project Management Organization
- Project Committees and Reviews and Stakeholders Management Plan
- Contracting Strategy
- Local content management plan
- Schedule and Budget

► Procedures

- Quality Procedures
- Document Management
- Training

► Administrative

- Delegation of Authorities
- Responsibilities
- Change Management
- Identification and Management of Interfaces
- Reporting and Action Tracking
- Insurance
- Permits

► Policy implementation

- Risk Management
- HSE, Security
- Sustainable Development



The Contractor's Project Execution Plan is based on the Contract Scope of Work
and includes the following items

- Project description, objectives, global environment, contractual obligations
- HSE & Quality Assurance objectives, plan / Coordination with Company
- Execution and Organization strategy (Partners / Nominated Contractors roles and responsibilities; organization charts, work split; communication and Project systems)
- Project Schedule key sequences, milestones, critical activities, constraints
- Engineering specific and key aspects / Procurement, Logistics / T&I strategy
- Fabrication/Construction contracts strategy / Use of local resources
- Site Construction / Commissioning / Hand-Over strategy
- Interfaces and their management / Project risk management

**The contractor organization is part of the global organization
which is supervised by the Project team**

Key points on FEL 3 - Basic Engineering



► Scope of Basic Engineering

- develop the concept selected at the end of the conceptual studies and studied in details during the pre-project phase
- prepare technical service contracts for the execution phase

► Project Scope and Integration

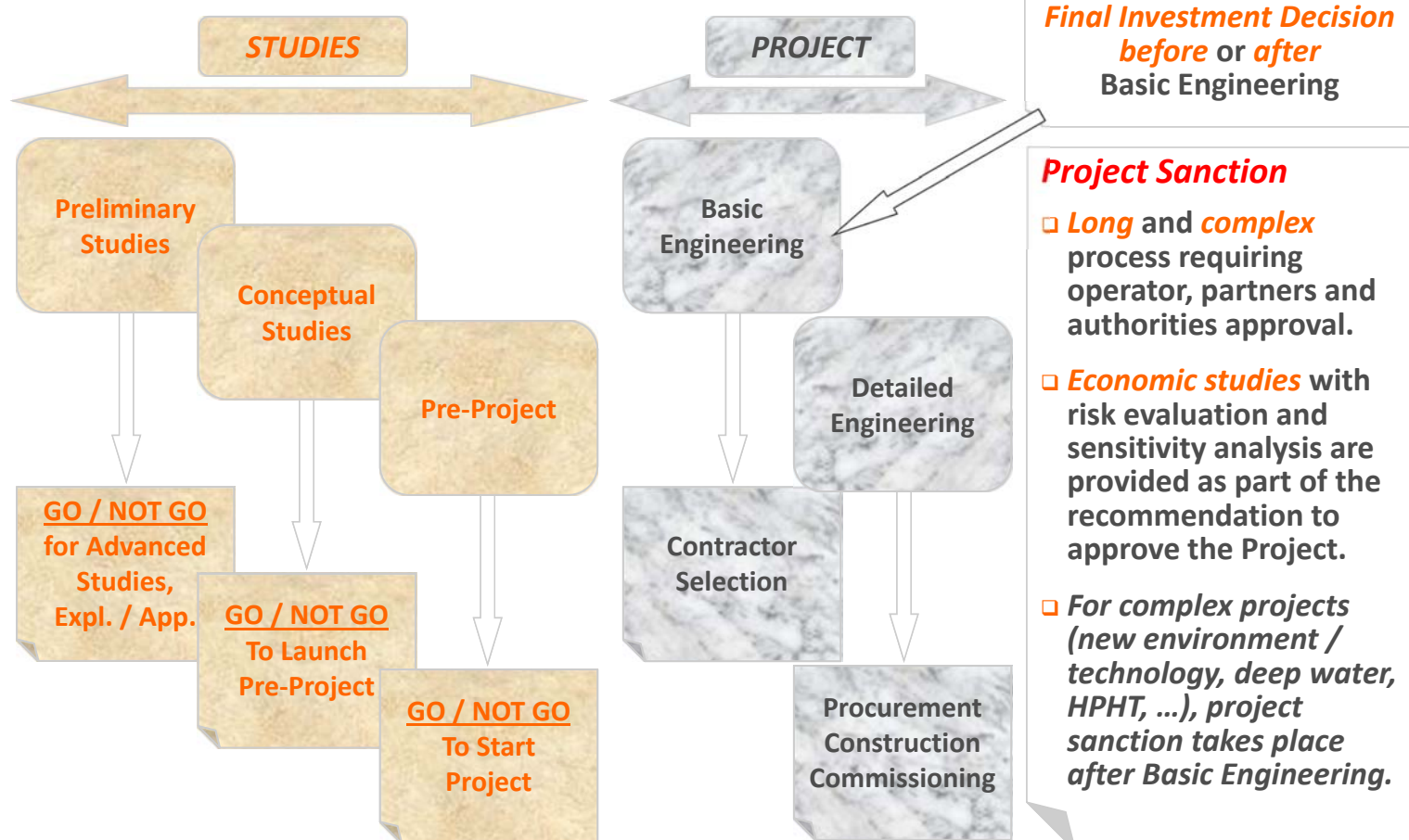
- Project scope definition says how to implement the detailed scope statement
- Integration Management helps Project Manager to make choices

► Breakdown Structures

- Used to define the various detailed levels of a project
- WBS (Work Breakdown Structure) / OBS (Organization Breakdown Structure)
- CBS (Cost Breakdown structure) / CoBS (Contract Breakdown Structure)
- RBS (Resource Breakdown Structure) / PBS (Product Breakdown Structure)
- BOM (Bill of Materials) / RiBS (Risk Breakdown Structure)

Final Investment Decision

Project sanction in the field development process



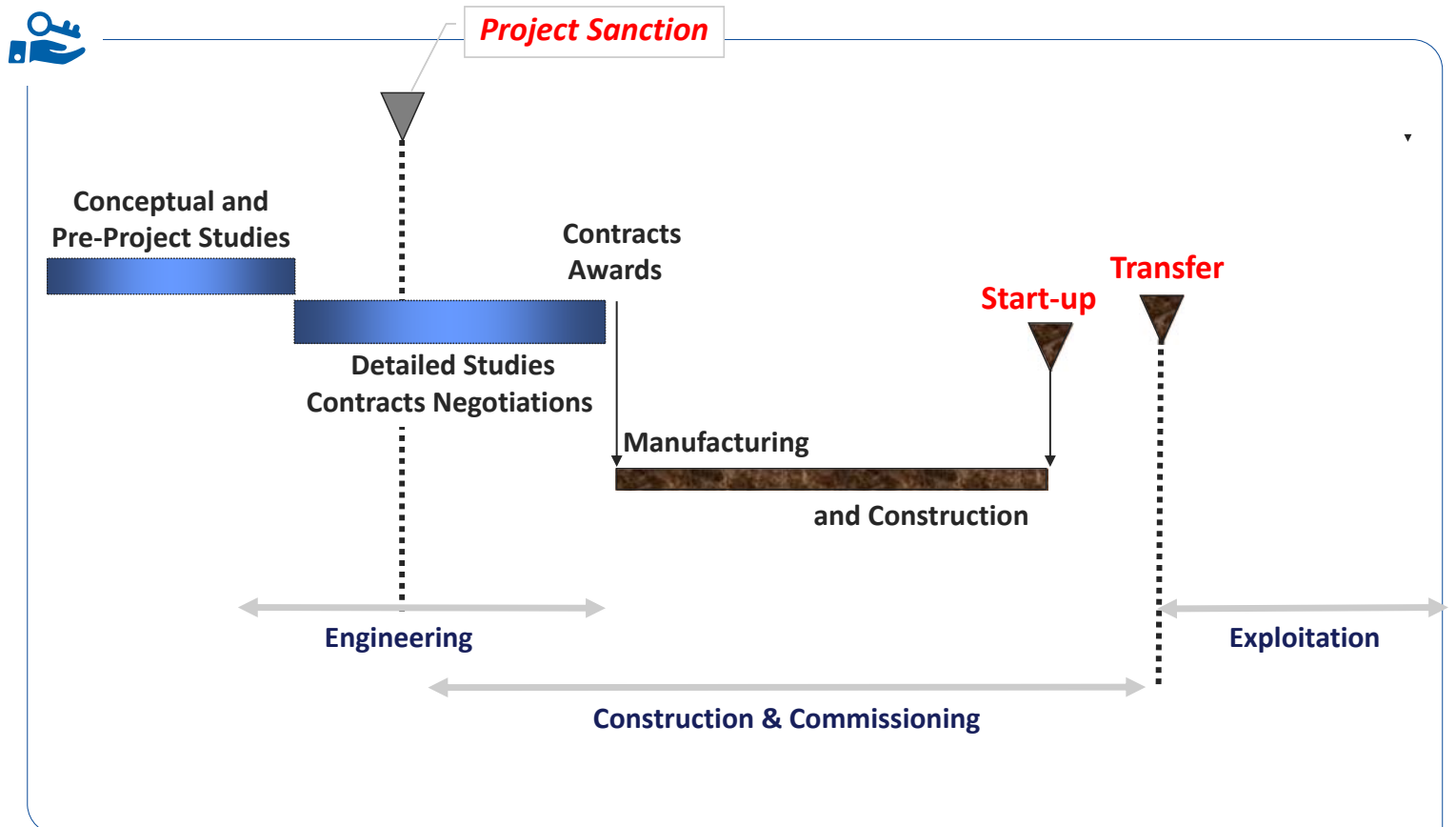
► Final investment decision is an internal process of the Company

- It involves the company's top management
- All project partners have their own FID process
- A dossier is prepared by the Project management
- It summarizes all studies carried out during pre-project and basic engineering

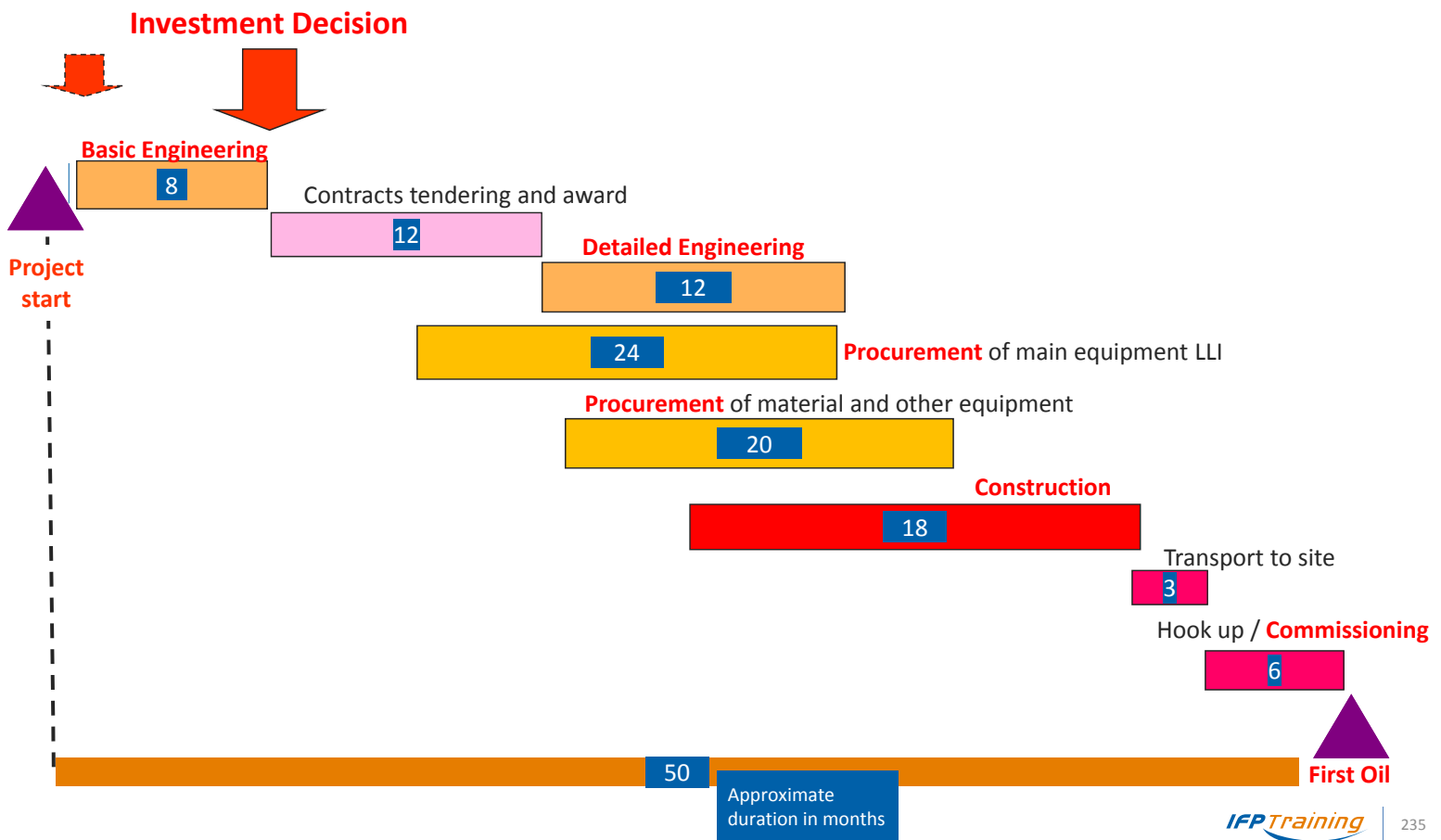
► The decision is based on several criteria

- Reserves range (2P for development concept, 1P for crash case)
- Development costs
- Production start-up date
- Economics

Project sanction and phasing



Typical planning



Long Lead Items

- ❑ **Long Lead Items selection** based on objective criteria and limited to:
 - Equipment that cannot be delivered on time at site if selected and purchased by the Contractor (e.g. rotating equipment).
 - Equipment requesting specific design finalisation to fit the requirement of the project (e.g. control system).
- ❑ Examples of LLIs: turbo generators, compressors, separators, control systems, pipes, etc.
- ❑ For an EPC contract, all tasks regarding the procurement and the initial steps of the supply of the LLI is under the **responsibility** of the Operator.
- ❑ LLI vendors are contracted directly by the Operator and then the contracts are **assigned** to the EPC Contractor.



- ▶ **Design** is prepared during basic engineering and the EPC contractor is contractually required to **endorse** it.

- ▶ **Objectives**
 - smooth **progression** of engineering from basic to detailed design and integration of agreed exceptions and clarifications.
 - confirmation of the **consistency** of the design with the scope of work and reduction of claims or changes.
 - acceptance of full **responsibility** for the Engineering, Procurement and Construction by the EPC Contractor.

Front-End Engineering Design contract



- ▶ FEED focuses on the technical requirements as well as the investment cost of the project.

- ▶ The FEED package is used as the basis of design in the bidding process of the execution phase contracts: EPC, EPCI, etc.

- ▶ During the FEED phase there is a close communication between the Operator and the Engineering Contractor to work on the project specific issues and avoid significant changes during the execution phase.

- ▶ It starts after a provisional project sanction and will normally be completed prior to project sanction.



Objectives of the contracting strategy

- Define the breakdown of the project in contracts / purchase orders
- Define the scope and remuneration mode of each contract

Several key aspects have to be taken into account in the overall strategy:

- **Project objectives:** schedule, cost, local content
- **Project scope:** size, innovations, technical uncertainties, interface
- **Risks:** technological, financial...
- **Market:** experience and availability of potential contractors
- **Patrimonial Contract/Joint-Operating Agreement:** tendering rules, approvals
- **Local content:** objectives in terms of % of cost/manhours
- **Legislation:** import, export, customs, taxes



► **Separate technical contracts**

► **Combined technical contracts**

- **EPC**
Engineering, Procurement, Construction
- **EPCI**
Engineering, Procurement, Construction, Installation
- **EPCC**
Engineering, Procurement, Construction, Commissioning
- **EPCIC**
Engineering, Procurement, Construction, Installation, Commissioning

► **Turnkey technical contracts**

- EPCIC + Start-up

Different types of technical contracts

COMPARATIVE CONTRACTUAL PLANS

SEPARATE CONTRACTS	EPCI	EPCC	TURN KEY
PREPROJECT	PREPROJECT	PREPROJECT	PREPROJECT
BASIC DESIGN	BASIC DESIGN	BASIC DESIGN PROCUREMENT LONG LEAD ITEMS	BASIC DESIGN
PROCUREMENT LONG LEAD ITEMS	PROCUREMENT LONG LEAD ITEMS		DETAIL ENGINEERING
DETAIL ENGINEERING PROCUREMENT	DETAIL ENGINEERING PROCUREMENT	DETAIL ENGINEERING PROCUREMENT	PROCUREMENT
SUPPLY OTHER EQUIPMENT	SUPPLY	ASSIGNMENT LONG LEAD ITEMS	LONG LEAD ITEMS
BULK MATERIALS	OTHER EQUIPMENT BULK MATERIALS	SUPPLY ASSIGNED L.L. ITEMS	OTHER EQUIPMENT
CONSTRUCTION	CONSTRUCTION INSTALLATION	OTHER EQUIPMENT	BULK MATERIALS
COMMISSIONING	COMMISSIONING	BULK MATERIALS	CONSTRUCTION COMMISSIONING AND START UP
OPERATING TESTS PERFORMANCE TESTS	OPERATING TESTS PERFORMANCE TESTS	CONSTRUCTION COMMISSIONING	OPERATING TESTS PERFORMANCE TESTS
		OPERATING TESTS PERFORMANCE TESTS	

Contract Remuneration

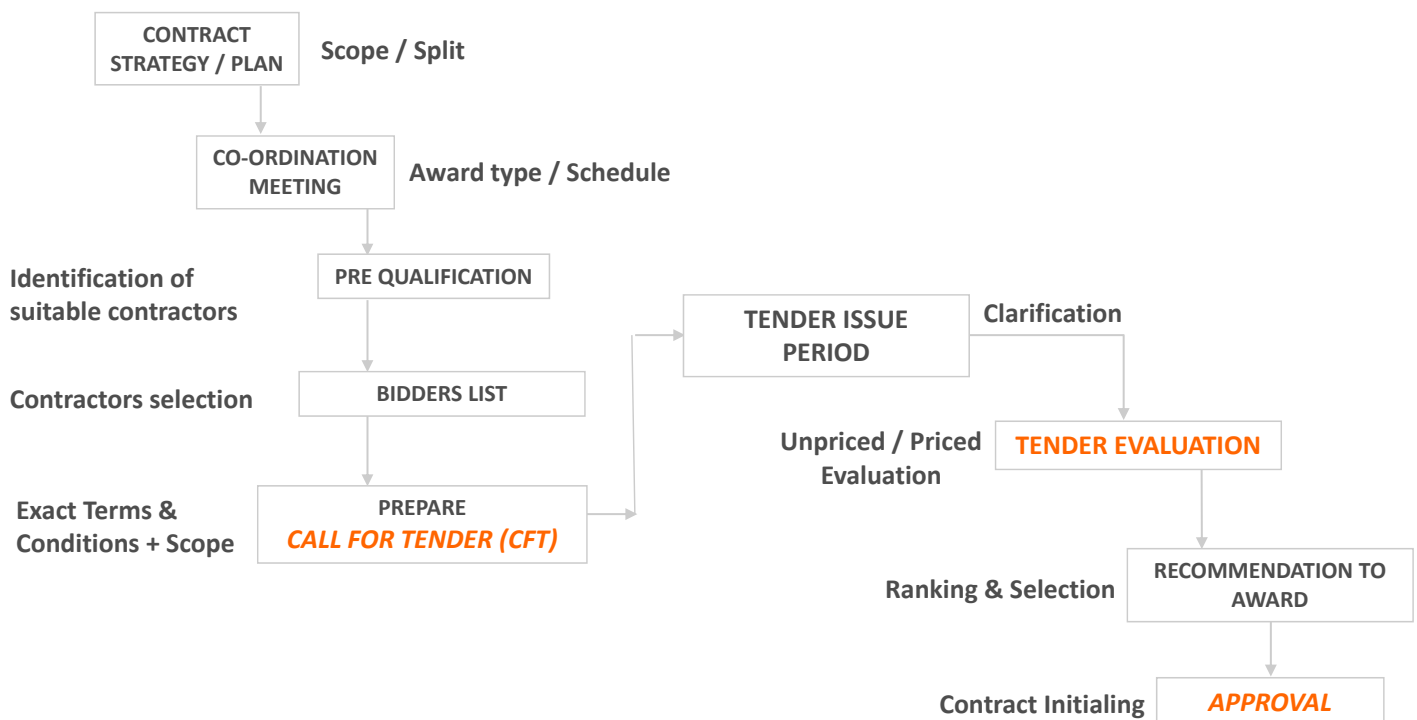
► Lump Sum

- Pros: clear definition of the work, final price fixed
- Cons: long negotiations before contract award, rigidity

► Reimbursable

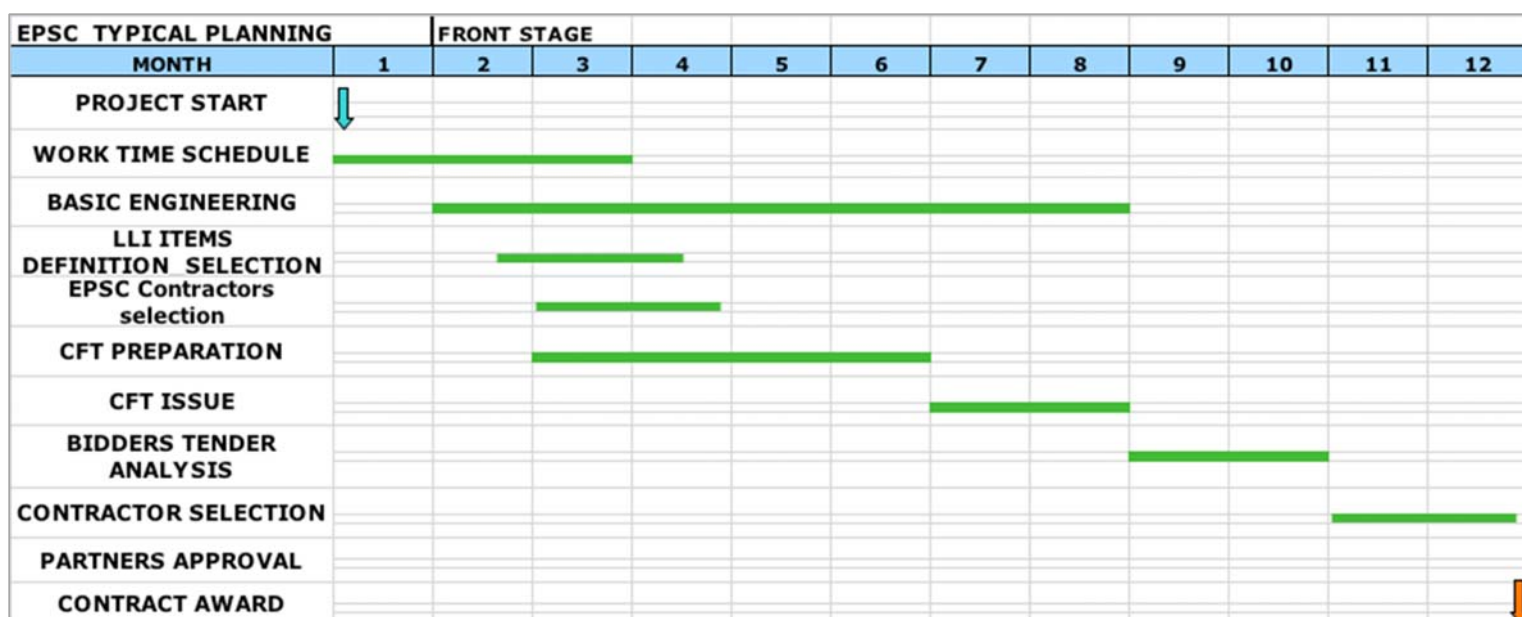
- With or without incentives
- With or without target price
- Pros: quick contract award, flexibility
- Cons: final price unknown, large supervision team

Key steps for contracting, purchasing and tendering



Tendering phases

The front stage work to be performed is critical for the success of the Project.
Contracts are prepared, agreed and awarded during this period.



Key actors in a project organization



Project Manager

in charge of the execution of the Project.

Platform Manager, Package Manager

in charge of the execution of the Works of the Contract.

Services Manager

in charge of implementing Project procedures for the Contract.

Contract Engineer

in charge of ensuring the application of all contractual terms and conditions and of filing up all contractual documents.

Planning Engineer

in charge of monitoring the time schedule of the Contract scope of work, including key dates, milestones and completion dates, progress verification as well as the assessment of any schedule impact or entitlement to extension.

Cost Controller

in charge of the evaluation of the overall Contract forecast, allocating cost codes, verifying, reviewing and evaluating Change Orders, verifying invoices and claims for payments and maintaining cost reports.

► Factors to be considered

- Strategic importance of the project
- Technical characteristics of the project
- Operator's experience in project management
- Project contracting strategy
- Location of the actors during the various phases of the development

► Organization principles

- Organization and contracting strategy are deeply interdependent
- Organization must evolve all along the main project phases
- Organization must suit the needs of all the actors of the project (Company, Partners, Contractors, Suppliers)



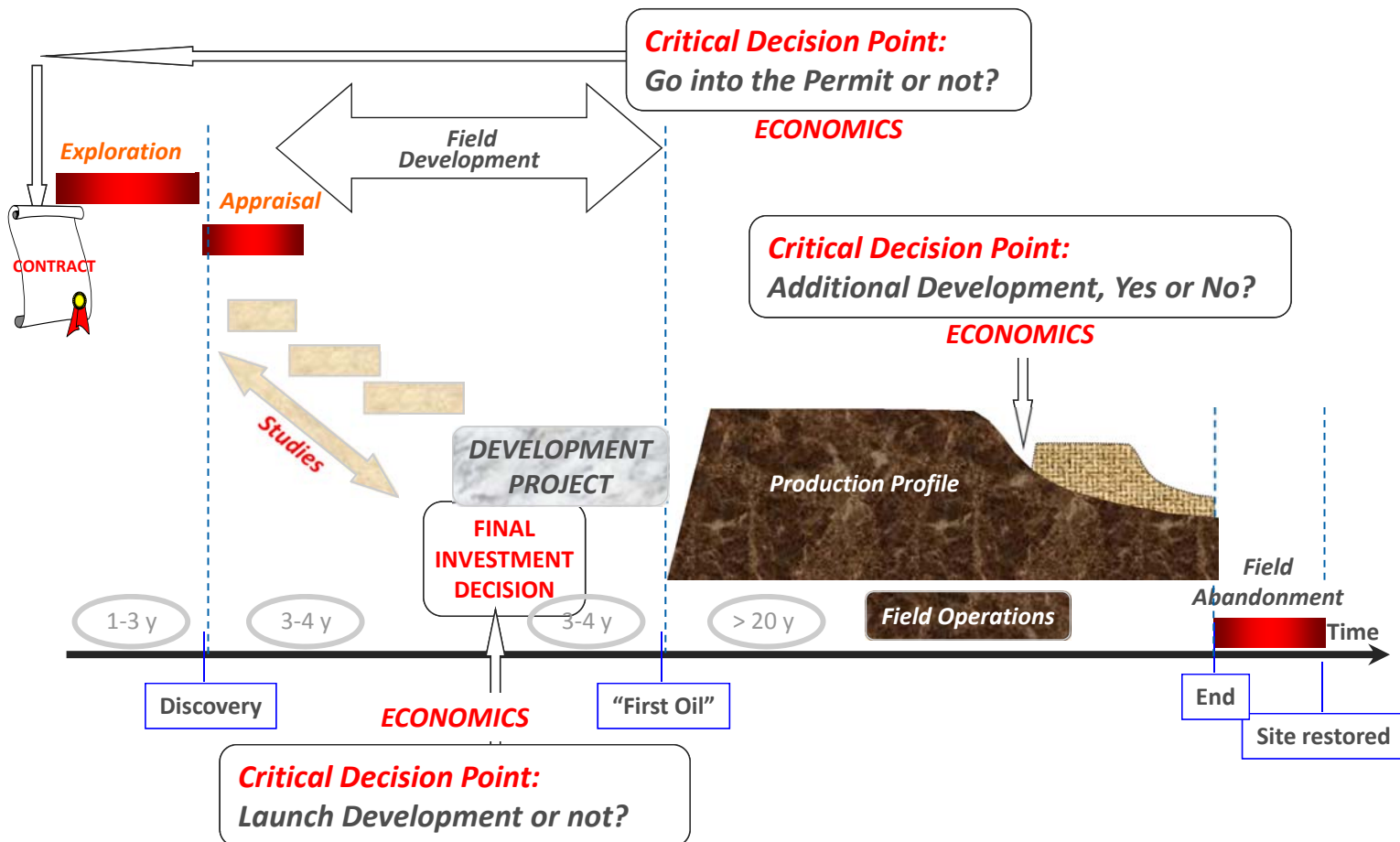
Typical project organization

► Project culture and management styles

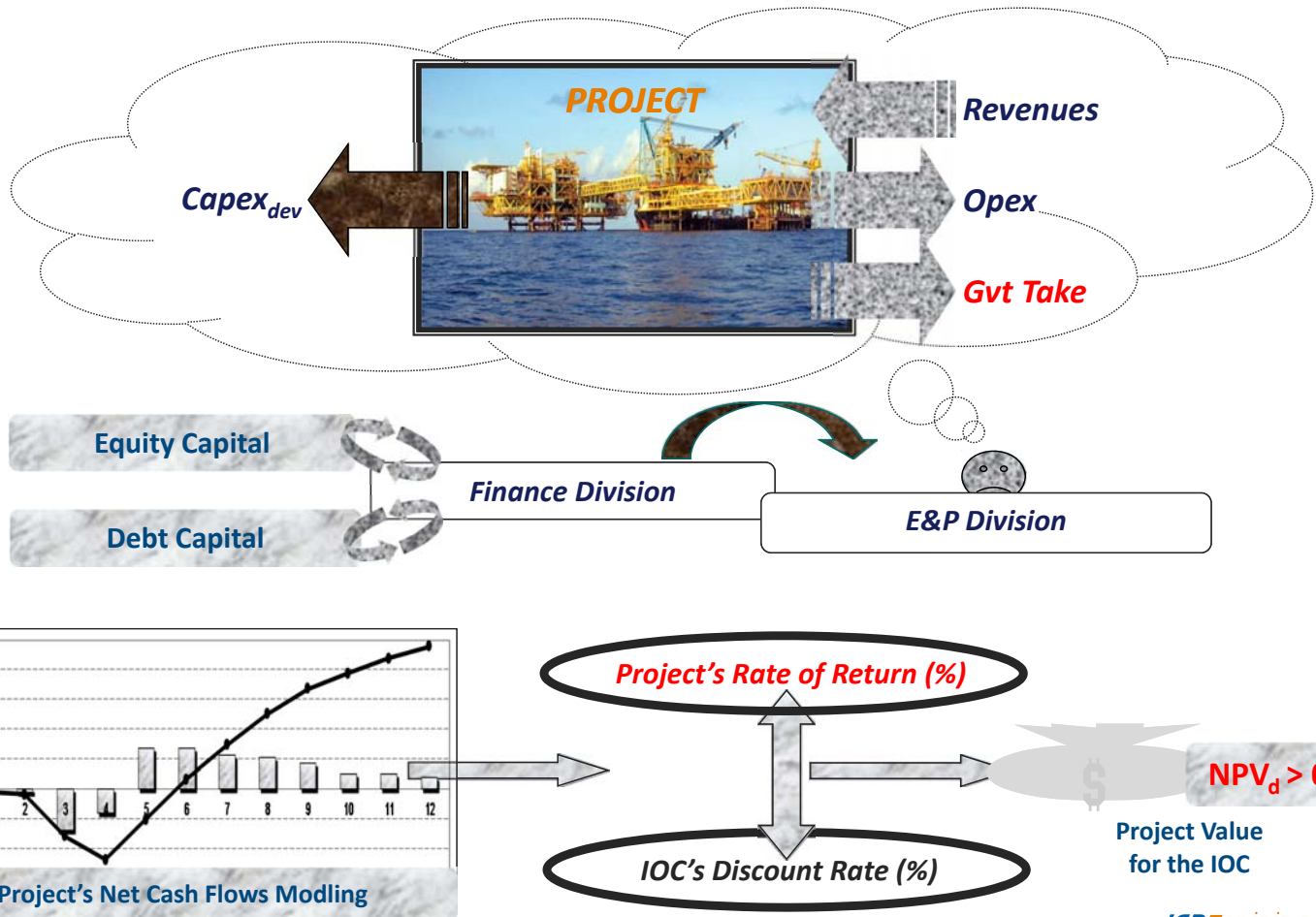
- Every organization has its own culture and this influences how projects are organized and executed
- E&P projects most of the time involve several organizations which have different cultures
 - Contracting in different countries
 - Joint-ventures or partnerships agreements
- To conduct major projects, organizations will partly rely on external resources integrated into their teams
 - Contractors come with their own culture

Key Points to Keep in Mind

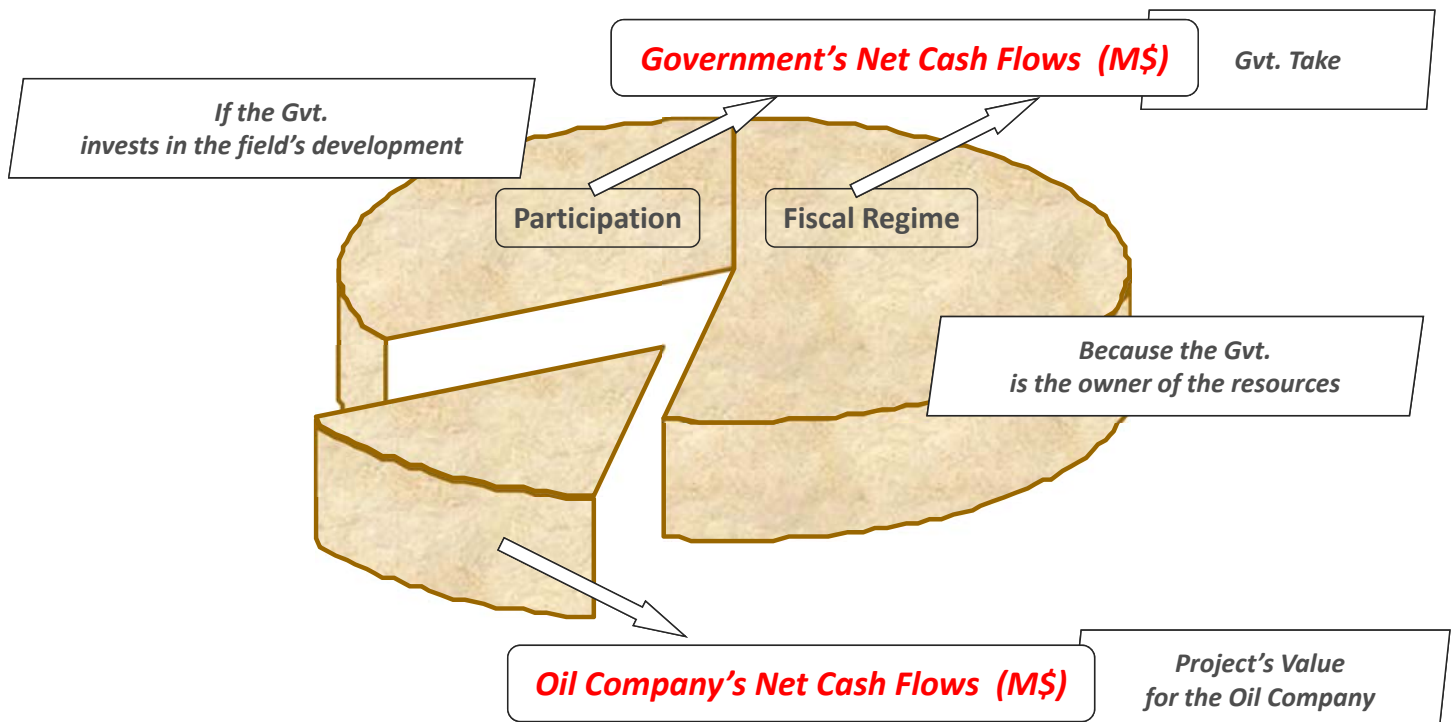
Critical decision points along the E&P chain



Financing, value creation and investment decision

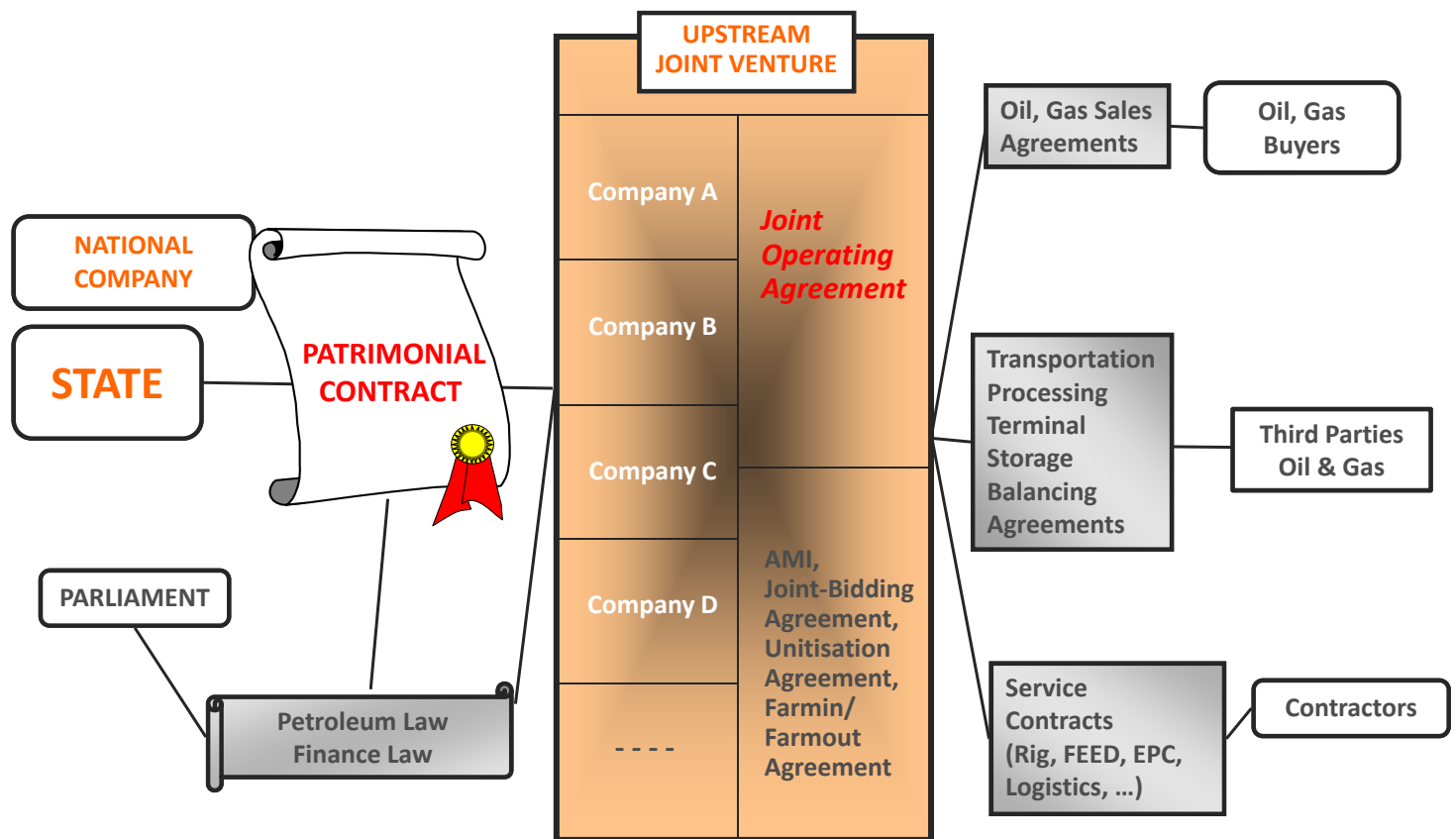


Sharing the value



$$\text{Total Economic Rent (M\$)} = \text{Price} * \text{Field's Reserves} - \text{Capital Expenditures} - \text{Operating Expenses}$$

Contractual framework

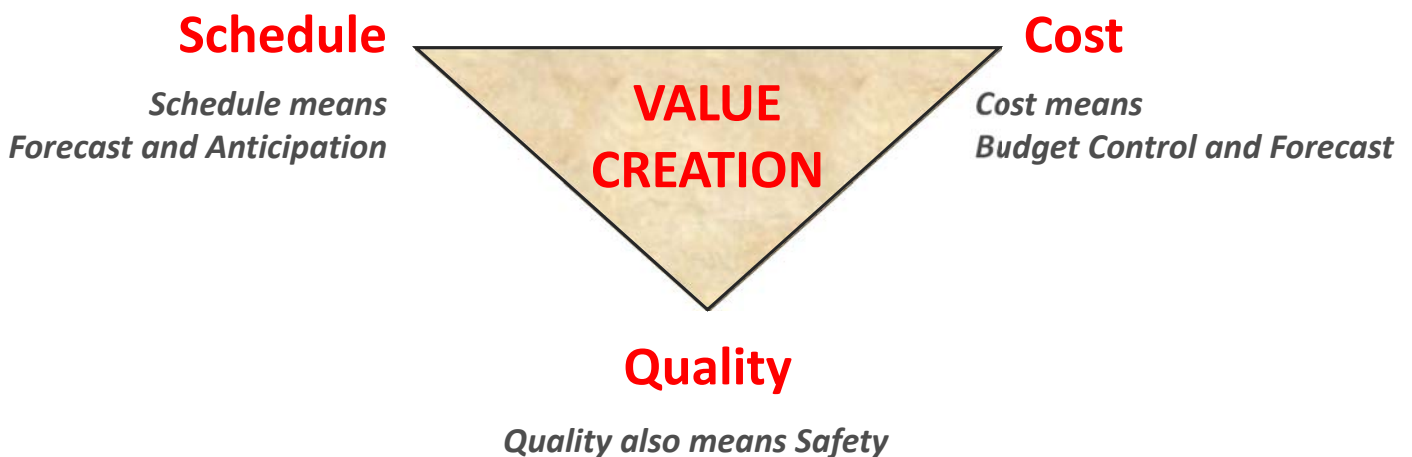


Project management

A project is a global approach to achieve a defined objective

A project is a method and a tool designed to control an industrial investment

A project is based upon an economic reality



The project team has to manage all three aspects

E&P value chain: 3 key processes



*requires an optimal contribution from all those involved along the value chain
in the three processes : Evaluation, Approval and Management*



Specialists

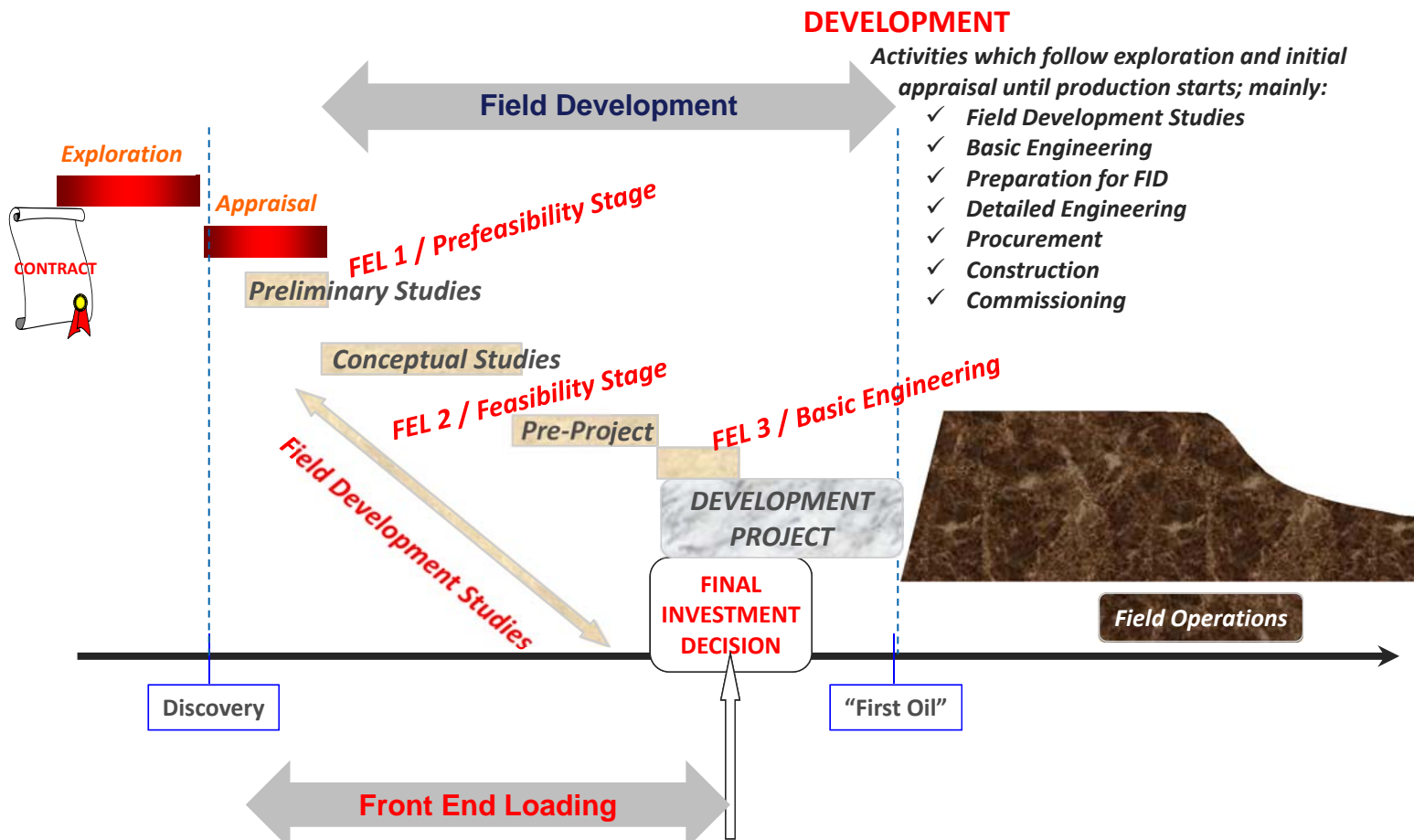
geologists, geophysicists, reservoir engineers,
production engineers, drilling engineers,
economists, tax specialists, negotiators,
lawyers, marketers, ...

Managers

project management, safety, environment,
finance, accounting, planning, cost control,
legal, insurance, human resources,
administration, ...

*A clear view of the overall picture of the E&P value chain
is essential for everyone.*

Front-End Development in the field development process





- ▶ **Objectives of preliminary studies**
 - To determine if moving to the feasibility phase is acceptable
 - To request additional reservoir information
 - To start traceability by going from one step to another through reviews
- ▶ **Preliminary scheme and technical feasibility**
 - Basis of study and constraints
- ▶ **Preliminary schedule and cost estimates**
 - Reliable order of magnitude
- ▶ **Economics**
 - Rough estimates of project's economics and uncertainties
- ▶ **Safety, environment and stakeholders issues**
 - Preliminary assessment

Conceptual study report (1/2)



- **Basis of Design**
 - ✓ Geographical, geotechnical and environmental data.
 - ✓ Petroleum, industrial and economic environment.
 - ✓ Seismic, exploration and appraisal wells data (logs, PVT, production tests, etc.)
 - ✓ Rules and regulations from Company, international and local authorities.
- **Subsurface**
 - ✓ Geological and geophysical evaluation.
 - ✓ Reservoir: depletion strategy, well count, recovery factor, reserves, etc.
 - ✓ Possible development schemes.
 - ✓ Screening of possible development schemes, including innovative solutions.
 - ✓ Selection of 3 to 4 schemes to be evaluated and compared.

Key points on FEL 2 – Feasibility Stage

Conceptual study report (2/2)



□ **Technical Description of Selected Development Concepts**

- ✓ Drilling and completion. Field layout.
- ✓ Gathering system, processing units, utilities and export system.
- ✓ Sustainable development and HSE. Operating philosophy.
- ✓ Project execution, planning and costs.
- ✓ Duration of field production, CAPEX and OPEX estimates.

□ **Comparison of Concepts**

- ✓ Recovery, operability, sustainability, risks, planning, economics, etc.
- ✓ Recommended development concept.
- ✓ Risks and uncertainties.
- ✓ Required data acquisition and scope for further studies.

Key points on FEL 2 – Feasibility Stage

Pre-Project study report (1/2)



□ **Basis of Design**

- ✓ Update of Conceptual Study Report (results of new surveys, wells, etc.)

□ **Subsurface Evaluation**

- ✓ Update of the subsurface section of the Conceptual Study Report.

□ **Well Engineering**

- ✓ Drilling & completion. Well monitoring and data acquisition. Well interventions.

□ **Process and Flow Assurance**

- ✓ Definition and sizing of gathering networks, processing facilities, export system and utilities.
- ✓ Process Flow Diagrams (PFDs) and Piping & Instrumentation Diagrams (PIDs).
- ✓ Main production parameters, chemicals,...

□ **Field Layout and Facilities, Sizing and Weight Estimates**

- ✓ Well centers, pipelines network, processing and utilities units, living quarters, offsite facilities.

Key points on FEL 2 – Feasibility Stage

Pre-Project study report (2/2)



❑ **Operating Philosophy**

- ✓ Operability, maintainability, equipment redundancy, plant availability factor.
- ✓ Manning. Operations support facilities. Consumables. OPEX.

❑ **Sustainable Development**

❑ **Safety and Environment**

- ✓ Safety concept. Environmental impact assessment.

❑ **Project Execution Plan**

- ✓ Project planning and costs. Contractual strategy.
- ✓ Local content. Risks and uncertainties.

❑ **Preliminary Plan for Site Abandonment**

❑ **Remaining Potential and Future Development**

Key points on FEL 3 - Basic Engineering



▶ **Scope of Basic Engineering**

- develop the concept selected at the end of the conceptual studies and studied in details during the pre-project phase
- prepare technical service contracts for the execution phase

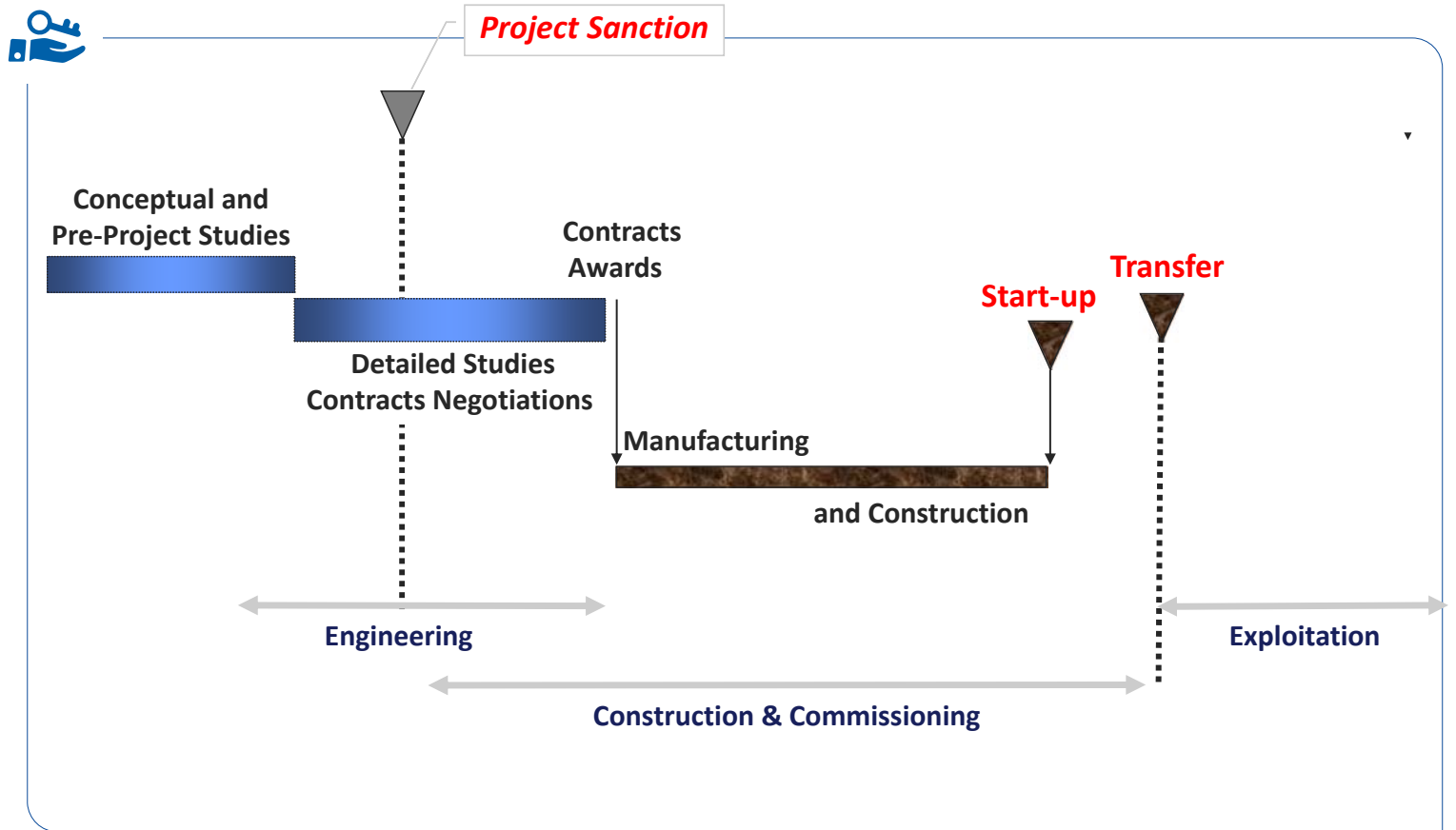
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- Project scope definition says how to implement the detailed scope statement
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Key phases of a project



Contracting strategy





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in charge of the execution of the Project.

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in charge of the execution of the Works of the Contract.

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